Living with Climate Change:

How Prairie Farmers Deal with Increasing Weather Variability

by

Kent Pearce

A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfilment of the requirements of the degree of

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THE UNIVERSITY OF MANITOBA

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A Thesis/Practicum submitted to the Faculty of Graduate Studies of The University of

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Of Master of Natural Resources Management (M.N.R.M)

Abstract

This thesis explores the concepts of resilience, adaptation and vulnerability of the Saskatchewan prairie agroecosystem to extreme weather events. The objectives of this research were (1) To determine how producers responded to weather related shocks and stresses; (2) To determine commonalities between successful area farmers and(3) To modify CRISTAL as a research tool. The research was based on 23 producer interviews conducted in the vicinity of Regina, SK and 15 interviewees conducted near Estevan SK, referred as the northern and the southern study area, respectively. Interviewees were structured using the computer based software "CRISTAL" and were completed between December 2006 and August 2007. Questions were focused within the time frame of 2001-2007, and aimed to determine (1)which recent weather events had a significant impact on farming operations; (2) the impacts of these events; (3) coping strategies to the weather events and (4)resources important to coping strategies.

Results indicate that both the south and the north study areas had been affected by weather events, primarily early frost, drought, flooding/excessive moisture and hail. Some producers actively adjusted their farming operations through innovations such as zero till, education and expert advice, direct marketing, 'next generation management', interdependence and speciality crop. These farmers, as compared to the others, fared better through extreme weather events and were better suited to react to future weather occurrences. Findings also suggest that government programs which were proactive in nature in responding to weather events where popular amongst producers and had more value than older, reactive government programs.

Acknowledgements

Firstly, I would like to thank my committee, Dr. Berkes (advisor), Dr. Venema (IISD), Dr. Koper (NRI), Dr. Johnson (Agribusiness and Agricultural Economics), and Darren Swanson (IISD). If it was not for their patience and support, this thesis would not have been possible. Their insight and guidance helped me through numerous challenges and their continued backing kept me on the road to completion. Thank you to my parents who have always provided me with constant belief and support. I would also like to thank the Holness, Fesciuc and Garton families who made me feel at home while I was in Saskatchewan.

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Chapter 1: INTRODUCTION

1.1 Background

The effects of climate change have become a relevant and important issue of national concern in the past decade. While significant debate remains over the extent to which humans have induced climate change, it has generally been accepted that the effects of climate change are manifested in terms of increased weather variability, a higher frequency of extreme weather events and decreased predictability (Berkes and Jolly 2001; Smit et al. 2003; Venema 2005). This increased frequency of climate related shocks and stresses and difficulty in predicting growing conditions poses a significant threat to the livelihood of producers in the Canadian Prairie agroecosystem (IISD 1997). The success or failure of agriculture is intimately tied to weather conditions. It is the ability of producers to deal with climate-related shocks and stresses and adapt to change that is essential for their survival (Turner et al. 2003; Wall et al. 2004; Venema 2005).

Successful adaptations to climate change are accomplished through actions that reduce vulnerabilities and build resilience. Generally speaking, increasing options and diversifying activities are two of the main ways producers can increase resilience (Turner et al. 2003; Walker et al. 2004). While this is not a new concept, its applicability to agricultural climate change adaptation has yet to be thoroughly explored. There already exists a wealth of knowledge on prairie agroecosystem resilience within the collective knowledge of producers. Producers may not describe their actions as building resilience. However, they have been adjusting their operations to changes in climate and advances in technology for generations. The nature of agriculture requires producers to be keen observers of change and have an intimate connection to their land. Building resilience into current agricultural operations may be a significant aid to producer's abilities to adapt to weather unpredictability associated with climate change.

1.2 Purpose and Objectives

The propose of this research was in part to meet the objectives of a larger collaborative effort including the International Institute for Sustainable Development (IISD), Agriculture and Agri Food Canada-Prairie Farm Rehabilitation Administration (AAFC-PFRA), and the University of Manitoba (U of M). The project was titled "Adaptation as Resilience Building: A policy study of climate change vulnerability and adaptation on the Canadian Prairies". It consisted of three phases including a vulnerability analysis, a resilience analysis and an adaptation priority analysis (Venema 2003).

This research helped fulfill the University of Manitoba's resilience analysis phase of the project, focusing on Saskatchewan and helping to build on the information gathered in Manitoba by Peter Myers. The specific objectives of this research were:

- To determine how producers responded to weather related shocks and stresses
- To determine commonalities between successful area farmers and to highlight their actions
- To Modify CRISTAL[1] as a research tool

[1] Crystal is a tool developed by consortium of organizations including the International Institute for Sustainable Development for purposes of helping development assistance agencies to better understand the climate change adaptation needs of their projects (http://www.iisd.org/security/es/resilience/climate_phase2.asp)

Chapter 2: LITERATURE REVIEW

2.1 Resilience, Adaptation and Vulnerability in Agroecosystems

Resilience is a term and concept first developed by ecologists to describe the characteristics of ecosystems that maintain themselves during a disturbance produced by various forces. This notion has since been used in the realm of social science to describe social resilience as "the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change" (Adger 2000). Although ecological and social resilience are often separately defined, they are inextricably linked by human dependency on ecosystem services (Berkes et al. 2003). As a result of this link, Walker et al. (2004) consider social-ecological resilience holistically as "the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedback." This recognizes that while social institutions are subject to external pressure and shocks from both political and economic change; their ability to absorb these disturbances depends both on social capital and the characteristics of the resource system (Adger 2000).

Walker et al. (2004) identify four critical aspects of resilience. They include:

- Latitude- the maximum amount the system can be changed before losing its ability to recover
- Resistance- the ease or difficulty of changing the system
- Precariousness- the current trajectory of the system, and how close it currently is to a limit or "threshold" which, if breached, makes recovery difficult or impossible
- Panarchy- how the above three attributes are influenced by the states and dynamics of the (sub)systems at scales above and below the scale of interest

The degree to which each of these four aspects are present determines the overall

resilience of the system.

Closely connected to the notion of resilience is that of adaptability. Essentially adaptability is the capacity of the actors in a system to influence resilience (Walker et al 2004). In a social ecological system, adaptability is greatly influenced by the natural setting of the system but more directly it is a function of the social component. It is the actions of individuals or groups which either intentionally or unintentionally influence resilience. Walker et al. (2004) note that "it is the collective capacity to manage resilience intentionally which determines whether the system can successfully avoid crossing into an undesirable system regime, or succeed in crossing back into a desirable one." Walker et al. (2004), in corresponding with their four critical aspects of resilience, point out that actors can move thresholds away from or closer to the current state of the system by:

- Altering the threshold- actors can move thresholds away from or closer to the current state of the system
- Altering resistance- making the threshold more difficult or easier to reach
- Altering precariousness- moving the current state of the system away from or closer to the threshold
- Altering panarchy- managing cross-scale interactions to avoid or generate loss of resilience at the largest and most socially catastrophic scales

Vulnerability is often referred to as a loose antonym of resilience (Adger 2000), or rather, "the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation or stress/stressor " (Turner et al. 2003). It presents itself in two ways: through exposure to a shock or stress and in the resilience of the system experiencing the disturbance (Turner et al. 2003). While vulnerability may be considered an antonym of resilience, Berkes (2006) demonstrates that resilience thinking relates to vulnerability in three key ways:

- provision of an integrated, holistic approach for assessment of shocks and stresses

- placing emphasis on learning from shocks or stresses, and incorporating the lessons through feedback mechanisms; and
- adopting methods to deal with future uncertainty associated with unknowable shocks and stresses, thereby increasing resilience

2.2 Adaptation to climate change and variability

Most agricultural activities are inherently sensitive to weather variability and this may result in the agricultural industry being extremely vulnerable to climate change. Adaptation to climate change is not only essential to maintain agricultural production and for agricultural economies and communities to remain in existence; but also to reduce vulnerability for future generations (Government of Canada 2004). The vulnerability of the Prairie agroecosystem to climate change and weather variability is greatly influenced by its adaptive capacity and it is because of this reason that recent climate change research has been increasingly directed towards the issue of adaptation (Bradshaw et al. 2004).

Adaptations to climate change and weather variability are extremely varied. Bradshaw et al. (2004) and Smit and Skinner (2002) identify several attributes which can be used to characterize adaptation measures. They include:

- Intent and Purposefulness- differentiates between adaptations that are undertaken spontaneously, or autonomously as regular on-farm management
- Timing and Purposefulness- differentiates between responses that are anticipatory, concurrent or responsive
- Scale and Responsibility- distinguishes the scale at which adaptations occur and the agent responsible for the development and employment
- Form- the process, form and scale used by the producer for adaptation

These adaptation measures may occur at varying scales. For example, adaptation may occur at the organizational level through technological advances such as crop development, machinery improvements and weather forecasting (Smithers and Blay-

Palmer 2001). Adaptation also occurs at the farm level through tactical and strategic adaptations. Tactical adaptation would include practices such as changing planting times, input uses and harvesting to accommodate weather variability. Strategic farm-level adaptation would take the form of alteration of soil management practices, selection of crop varieties, purchasing crop insurance, or diversifying their farming operation (Bradshaw et al. 2004).

Smit and Skinner (2002) group agricultural adaptation options into four non-mutually exclusive categories. The first is technological developments. Technological research and development is one of the most frequently advocated strategies for adaptation to climate change (Smithers and Blay-Palmer 2001, Bryant et al. 2000). While this statement is true, Smithers and Blay-Palmer (2001) indicate that although this is the perception, research and development have received little explicit consideration in the context of climatic constraints on food production and complete faith in technological developments for climate change adaptations would be unwise.

The second category as identified by Smit and Skinner (2002) is government programs and insurance. These programs have the power to greatly influence farm-level production and management strategies as well as technological and research developments (Smit et al. 2000). Government income stabilization and disaster relief have the potential to stabilize farming incomes during times of weather variability associated with climate change (Smit and Skinner 2002) however programs such as crop insurance have been found by Smithers (1998) to decrease producers adaptive measures such as diversification and off-farm income.

Farm production practices are the third category. This involves changes in the actual operation of the farm. As mentioned above, this may be highly influenced by government programs. This category ultimately describes farm-level decisions with respect to farm production such as land use, irrigation and operational timings (Smit and

Skinner 2002).

The final category is farm financial management. This again is highly influenced by government agricultural support. It is a farm-level response using farm income strategies to reduce the risk of climate-related income loss (Smit and Skinner 2002).

Few researchers have addressed adaptation in analyzing the decision making process at the farm-level. What has been identified by an interim report produced by the Canadian Senate (2003) is that:

- Adaptation in agriculture is driven more by the vulnerabilities associated with extremes
- Adapting in a reactive way could be costly
- Adaptation strategies are specific to locations and settings
- Adaptation to climate change is one component of risk management strategies for producers

2.3 Prairie agroecosystem regional studies

The Prairie agroecosystem is located in the physiographic region known as the Western Interior Basin and is well known for its combination of rich soils and favourable agro-climatic conditions (IISD 1997). This combination has resulted in a significant amount of Canada's agricultural production coming from this region. The Prairie agroecosystem is however very vulnerable to drought. The region historically has seen devastating periods of drought in the 1930's and 1988 (IISD 1997). Climate change is predicted to bring increased periods of drought along with a greater degree of weather variability. Shindler and Donahue (2006) predict that "near future climate warming, via its effects on glaciers, snow-packs, and evaporation, will combine with cyclic drought and rapidly increasing human activity in the Western Prairie Provinces to cause a crisis in water

quantity and quality with far-reaching implications." This prediction of an impending water crisis is supported by Agriculture and Agri-food Canada's 2005 synthesis report on the 2001-2002 droughts. Their analysis revealed three findings. The first was that major droughts were relatively rare in the 20th century and that more severe, decade-long droughts have historically occurred on a more frequent basis and may possibly do so in the future. Second, the increase in demand for good quality water will increase water system stress in drought periods and finally, most global climate models are predicting increased temperature and evaporation with less precipitation in the Prairie agroecosystem (Agriculture and Agri-Food Canada 2005). The 2001-2002 drought analysis also showed some adaptation trends. Preventative adaptation measures such as farm management practices to reduce wind erosion were found to be a success. Reactive adaptation measures were found to be less effective and more costly. The resulting conclusion was that earlier recognition may have enhanced the Prairie agroecosystem's adaptation capacities (Agriculture and Agri-Food Canada 2005).

Land managers, watershed managers, and policy makers have seldom, if ever considered the cumulative effects of climate change, drought and human activity as well (Schindler and Donahue 2006). Venema (2005) supported this claim in his review of ag-water policies in Prairie Canada. He finds that:

- Very few watershed plans have actually been completed within the Prairie provinces; even fewer have been implemented
- No formal learning mechanism exist to coordinate watershed-planning techniques among the provinces, nor does any coordination mechanism exist for interprovincial watershed planning

In addition Venema (2005) indicates there is no consensus and no clear direction on:

- The role/type of decision support tools and the degree to which the watershed planning process will be transparent and participatory
- How technical capacity requirement for local watershed planning will be met

- The use of economic instruments to finance watershed planning and management

These concerns of drought in the prairies were also brought forth by Wall et al. (2004). They do however note that some agricultural opportunities may also come forth. "Extended droughts and increases in temperature appear to be the conditions causing the most concern while longer growing seasons offer potential increases in yield and diversity of crops grown". In adapting to climate change manifested through weather variability Wall et al. (2004) go further to suggest some specific Canadian based suggestions. First they recognize that producers adapt to climate change in conjunction with other business risk management strategies, therefore a "whole-farm" approach should be used for understanding farm-level adaptation. Keeping this in mind, Wall et al. (2004) suggest that agricultural adaptation policy would be more effective if it is integrated into existing programs. They also note that there is currently a knowledge gap in climate change adaptation research. To date most climate change research has taken a top-down approach, focusing on greenhouse gas emission reduction instead of acknowledging the need for understanding adaptation to altering conditions. This top-down approach is removed from agriculture in that the producer's lived experiences are not considered. Using knowledge from producers with the vulnerability approach finds what is known among the agricultural community; it incorporates producer based experience and knowledge and builds on existing capacity (Wall et al. 2004). Examples of this type of research are available. Wall and Smit (2005), in a review of agriculture climate change research, found that producers (in general, not specifically the Prairies) respond in some innovative ways to climate change (Table 1). Their finding further demonstrated that "adaptations to climate change are not just discrete technical measures, but are modifications to farm practices with respect to multiple (climatic and non-climatic) stimuli and conditions" (Wall & Smit 2005).

In light of the specific research preformed in regards to agriculture and climate change.

Wall et al. (2004) identify a large gap in adaptation research. As this areas of research is viewed by many to be one of the most effective in practically dealing with weather variability attributed by climate change, they make several recommendations to address this gap. They include:

- Enhancing the knowledge of producers experiences with climate and weather risks and how these affect adaptation choices
- Incorporating knowledge of farm production practices and management so that linkages to existing (and future) programs and policies can be identified and acted on
- Ensuring that climate scenarios and related models include agro-climatic conditions identified as relevant by the agri-food sector
- Encouraging climate change related research projects to incorporate whole farm perspectives

TABLE 1. Summary of how producers use sustainable agriculture practices to manage climate and weather risks (Wall & Smit, 2005)

Diversify Crops
• More perennial crops (eg., forges) are grown, thus improving drought tolerance by enhancing soil quality and moisture retention.
• Where possible, some producers are re-introducing native grasses for pasturing. These grasses are drought resistant when rotational grazing is practiced on them.
• Many Prairie producers are moving away from solid wheat production and growing a wide variety of new crops (e.g., pulses) that are more drought resistant.
• A diversity of crop types and varieties are grown in rotation and in different areas of farm properties. This spreads the risk of losing an entire year's production since conditions can vary across fairly small areas and different crops vary in how they respond to those conditions.
• When possible, some producers also stagger their seeding and therefore, harvesting dates by choosing a variety of crops that require a range of growing conditions so that crops are at a different stages (and therefore more or less vulnerable) if and when climate/weather conditions start having a negative impact.
Diversify Enterprises Within One Farming Operation
• Many producers are including more livestock in their operations to make use of increased forage production and to add value on the farm.
Land Resource Management
• Conservation tillage practices were cited by all producers as having several positive outcomes for reducing risks from drought. These include: reducing soil erosion; enhancing moisture retention; and minimizing soil impaction.
• Conservation tillage is also credited with limiting damage from run off and wash outs during flooding.
• Some producers are enhancing established shelterbelts and/or adding new ones. This can reduce negative impacts from drought by maintaining water tables, increasing biomass in soil, and ensuring surface moisture is kept on the land. Shelterbelts also provide protection from heat and wind for livestock, and can increase the heat units in adjacent fields.
• Some producers cut stubble at different heights to trap snow on field surfaces thereby enhancing spring moisture levels in the soil.
Water Resource Management
• The increase in drought conditions is leading to more interest in irrigation. Some producers are adopting newer, more efficient systems and timing for applications to avoid waste.
• Sloughs and ponds are managed to ensure water is captured and protected as much as possible.
Livestock Management
• Some producers who were affected by drought arranged to move some cattle out for winter feeding.
• In some cases, intensive grazing leads to doubling the number of cattle on same acreage, increasing economic returns.

2.4 Best Practices of Leading Farmers

The best practices of leading farmers was an initiative undertaken by the Saskatchewan Agrivision Corporation with the hypothesis that solutions to the problems that farmers already face can be found amongst the actions of successful or leading farmers (Best practices of Leading farmers 2004). 153 leading farmers were interviewed in Manitoba, Saskatchewan, Alberta and British Columbia. The results found commonalities between respondents. They include:

- They are all family-based operations which tend to have full time staff
- Most are corporate farms with the family members as shareholders
- Many are larger in size often including high-value operations
- Most still produce some traditional grains and livestock but also market directly to consumers

The best practice group found that collectively as a region, Western Canada has had a history of reacting defensively to change. The results of this reaction is heavy use of government aid programs, loss of rural population from frustration and disappointment, and a stagnate rural economy. Conversely the producers who are responsive to change have found success and new opportunities in agriculture by understanding what the market needs and having the willingness to change their operation to meet demands (Best practices of Leading farmers 2004).

Chapter 3- METHODS

Research Areas

Research was concentrated around a north and south study area. These research areas were determined through the use of a vulnerability map produced by the IISD and PFRA using 2001 census of agriculture data and six determinants of adaptive capacity (based on Smit *et al.*, 2001): (1) economic resources; (2)technology; (3) infrastructure; (4) information, skills and management; (5) institutions and networks; and (6) equity (Swanson et al. 2007). The vulnerability map produced using these determinants showed that areas with the highest adaptive capacity were clustered near large urban centres while areas of lower adaptive capacity tended to be clustered along the northern boundary of the Prairie agricultural region (Swanson et al. 2007). Based on this information a northern study area was chosen around rural municipalities (RM's) of Pense #160 and Redburn #130 and a southern study area around the RM's of Benson #35 and Estevan #5. Both study areas were similar with respect to their past exposure to precipitation variability, but differed in their relative adaptive capacity (Venema 2005). Using the vulnerability map it was determined that the northern study, with its proximity to Regina, had a higher adaptive capacity than the more isolated southern study area. The research performed in this thesis was performed without knowledge of the differing adaptive capacity potential of the two areas.

3.1 Northern Study Area

Research began in the northern study area shortly before Christmas of 2006. The first research activity consisted of touring the district and speaking to local residents about the general characteristics of the region and topography.

The eastern edge of the RM's of Pense and Redburn begins approximately twenty kilometres west of the city limits of Regina (Figure 1-2). This area of the province is

considered to be ideal for the growth of cereal crops and is known provincially as the Southern grain belt (See Appendix D for additional photos). A general scan of the area revealed very little in the way of trees, natural wind barriers, wetlands or significant changes in elevation (Figure 1-1). Exploring the area further revealed that farming practices in the area are fairly uniform. The more southerly RM of Redburn is almost completely dominated with grains, oil seed and pulse crops production. There is the occasionally sheep and cattle operation however mixed farms in the area are rare. As one area producer put it "the soil conditions here are excellent for grain production, you don't have rocks or any real obstacles, using it as grazing land would be a waste" (RM of Redburn Resident, January 2007).

Figure 1-1- Example of terrain in the Northern Study area

The main service centre in the RM of Redburn is the town of Rouleau, Saskatchewan. Rouleau is known nationally to Canadians as the fictional town of Dog River in the popular television show "Corner Gas". Like Dog River, Rouleau, Saskatchewan is

representative of many small towns in the area. As of 2006, its population was 400 residents, a 0.9% decrease from the 2001 census (Statistics Canada, 2006). Rural depopulation and its close proximity to Regina (approximately 40 kilometers) have had an obvious effect on the community's economy. While the community still had a school, post office, bank, hardware store and gas station, it was apparent that the area is close enough to Regina that most of the area residents make the trip to the city for the majority of their larger purchases. As with many of the other existing communities in the RM, Rouleau's grain elevator has been decommissioned and is now used as a private grain storage facility for one area producer. Drinkwater, Briercreast, Hearne and Pittman are the other small communities in the RM of Redburn.

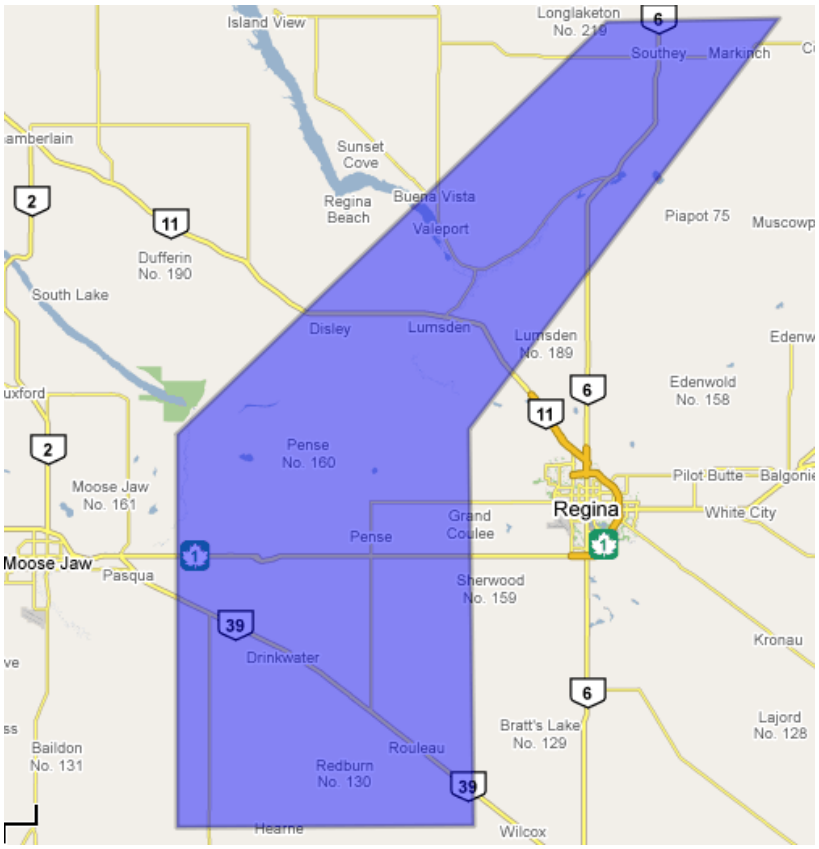

Figure 1-2. Approximate boundaries of Northern Study area

The RM of Pense is located directly north of the RM of Redburn and contains more variety in its terrain and farming practices. The southern half of the RM is nearly

identical to that of Redburn consisting near exclusively of grain, oil seeds and pulse crop production. As one travels north into the RM, the terrain becomes more varied closer to the Qu'Appelle valley. This results in a higher degree of varied terrain and a larger presence of vegetation. As such this area had more mixed farming operations, the use of some irrigation and a larger livestock component.

Besides agriculture, there are numerous other economic activities in this RM. A major employer in the area is the Mosaic Potash mine located near Belle Plaine, north of the Trans Canada Highway. Directly adjacent to this large mine is the Canadian Salt company, Saskerco Products and the Terra Grain Fuels ethanol production facility which was under construction. Many employees of these companies live in the RM's main service community of Pense. Much like Rouleau, the close proximity of Pense to Regina has resulted in the departure of many services. Other communities in the RM include the village of Belle Plaine and the Hamlets of Keystone and Stony Beach.

Due to the participatory nature of the research being undertaken and limited number of active producers in the RM's, some further research was conducted outside of the two northern study area RM's. Several interviews ended up taking place in the RM's of Cupar #218 and Abernethy #186. Both located to the north east of Pense and Redburn. The farms in this location were similar but of a much smaller size making interview referrals simpler. Terrain and farming practices were comparable and effect of being located near Regina could still be seen.

3.2 Southern Study Area

The southern study was centered around the RM's of Benson #35 and Estevan #5. Research began in these areas in February of 2007. Located approximately 170 kilometers south east of Regina, the geographic conditions of this area are quite different than those in the North. My initial sense of this area of Saskatchewan was that it is more

much similar to that of western Manitoba. The terrain in this study area, as shown in figure 1-3, is much more varied with more vegetation, wetlands and topographic relief then that of the northern study area. This variation tends to increase slightly as you move further east towards the Manitoba border. This wider variety in vegetation makes the area much more conducive to smaller, mixed farming operations.

Figure 1-3. Typical Southern study area terrain

From the geographic and agricultural activity perspectives, there was not a large variation between the RM of Benson and that of the RM of Estevan, however a major difference could be seen in income levels between the two municipalities. The RM of Estevan is located in one of the most energy rich areas of the province. In fact the city of Estevan is known as the "Energy City" with an approximate population of ten thousand inhabitants. In reality a large portion of the RM is an open pit coal mine used for Saskatchewan power generation. In addition to the large development of coal, oil and gas is also very prevalent in the region with pumps visible throughout the area.

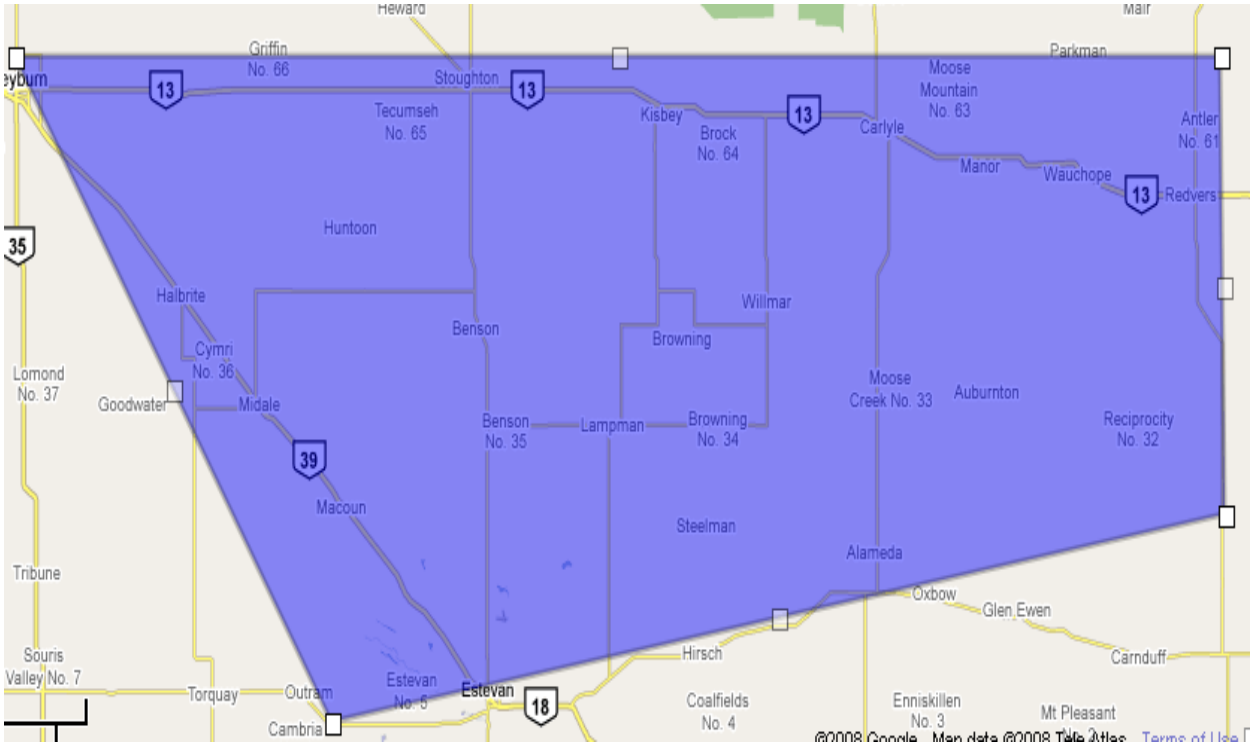

Figure 1-4. Southern Study Area

The RM of Benson, located directly to the north of Estevan, is much more agriculturally based. Oil and gas pumps are seen in this area and do provide income to the residents, however with the city of Estevan to the south and the town of Stoughton to the north, the RM's population is quite small. As with the Northern study area, due to the participatory natural of the research interviews were conducted outside the RM boundaries (Figure 1-4). Other RM's which were involved included the RM of Moose Mountain #63, the RM of Antler #61 and the RM of Weyburn #67. Farm size and type did not vary significantly between these RMs.

3.3 Recruitment of Interviewees

Recruitment of participants was one of the most challenging aspects of the research undertaken. Coming to the research areas, I had no prior knowledge of any of the inhabitants or organizations present. Beginning the interview process without a local

“in” required a continual evolution of recruitment techniques. I began my research in the northern study area close to Regina. In speaking with local residents I learnt that many farms in this area were extremely large. This meant that although the landscape may have been dotted with farm yards, the majority of the land was owned or rented by a single individual who may or may not live in the RM. In order to learn more about the area and to hopefully get some potential interviews, I began by contacting the local RM of Redburn municipal council. Because I had just missed the monthly council meeting, I proceeded to send each council member (7 members in total, the reeve and 6 district representatives) a letter containing information about myself and the research project. I had hoped that this would help avoid any confusion to my presence in the area as well as start a line of communication with a least one farmer in each RM district. The letters I sent out stated my research topic and asked for any help that could be provided. Of the seven letters I sent out, I received one response from an innovative council member located near the town of Rouleau.

In addition to sending letters, I also posted information sheets at public gathering points such as the post office, bank, RM offices and community centres. The main purpose of doing this was not so much to recruit as to get myself known in the community so that when I or a council member approached producers regarding the survey I wasn’t a complete stranger.

Because of the relatively low response rate with letters, I began speaking directly with RM councils. I would call the council office and ask to be placed on the monthly council meeting agenda. On the day of the council meetings I would come prepared with a brief 10 to 15 minutes presentation outlining who I am, where I was from, what I was researching and asking for assistance from the RM. I was universally well received. Most council members were life long residents of the area and veteran producers. Generally most thought the research idea was an excellent topic and were happy to see

someone conducting face to face interviews. Most RM's agreed to speak with area producers and hand out information packages at rate payers meetings. Despite this positive response however resultant interviews were small.

The challenge in obtaining interview subjects forced me to think of other recruitment techniques. For this I turned to the Internet. The first source of technology I employed was the brand new social networking tool at the time, Facebook. Facebook is a online program which connects friends and their respective social groups. Using this program I started a facebook group informing my group of friends of my research, what some of my difficulties were and asked for their help recruiting any family or friends that could help me. I was surprised by the effectiveness of this tool. Soon the group had well over a hundred members most of which I did not personally know but had been referred to by friends. The interviews that resulted from these referrals were excellent and each interview usually resulted in at least a few more introductions. I believe this recruitment method was more successful because I was introduced to the interview subjects as a friend. I was introduced by a local as a student needing help with thesis research. This helped reduced any scepticism about my research motives, my age or who I was working for.

Another recruitment tool from the Internet which proved extremely effective was a message board. Oddly enough it was a Canadian Football League on line forum that aided me the most in recruitment. I have been a lifelong Winnipeg Blue Bomber fan. As such I have been following and discussing the team on line with other fans since the Internet became widely available. The main rivals of the Winnipeg Blue Bombers have historically been the Saskatchewan Rough Riders. The rivalry can be quite heated at times but is generally very friendly. Because of this fact, I have been active on a Saskatchewan Rough Riders fan site for years. Partly out of frustration and chance, knowing full well that many members were producers or had family in agriculture, I

decided to post my research topic on this on line discussion forum and asked if anyone could be of assistance. Much to my surprise within 15 minutes of asking for help a producer from the northern study area answered my request. We agreed to meet in Regina on a game day. We quickly became friends over our mutual love of football. The interview I conducted went well and he agreed to let me visit his farm to experience and view first hand much of what he had been talking about. In doing so I was introduced to several of his neighbours and it quickly became the most successful recruitment technique of the entire project.

The final recruitment process I employed was door to door solicitation. This process proved to be very time consuming and highly ineffective. Using RM land owner maps I would visit each individual farm site. If someone was home I would introduce myself and try to set up a meeting time. If no one was home I would leave a notice of visit, stating who I am, my research topic and my contact information. I produced three notice of visit letters for each consecutive visit (after three visits and no contact I would assume they were not interest or not present). The main difficulty in this method was that although landowner maps would show a diverse amount of land owners, an extremely large proportion of these land owners rent their land to a relatively small amount of people farming it. As a result of this 10-20 farms could be visited before finding a person actively farming the land and in many cases that person could be away for an extended period of time or in fact living in Regina making their contact information difficult to obtain

3.4 Challenges and Limitations

I discovered through the research process several difficulties and challenges inherent with agricultural and student research. One of the first difficulties I encountered was over saturation of interviews. After conducting my first group of interviews it became clear that Saskatchewan producers are solicited for interviews very frequently, in some cases it

can be a weekly experience. Government, insurance companies and agribusiness all actively contact producers for information. Unfortunately the majority of these surveys are conducted over the phone, many from out sourced overseas services, and require yes/no and a,b,c,d, type responses. The lack of ability to express opinions, the detached feeling of the surveys and simply the frequency with which they are asked to complete them made recruitment for my research extremely difficult. Asking over surveyed people to sit down and speak with me for 30 minutes was a definite challenge. Adding to the difficulty was that I was from an out of province university, my youth and the lack of perceived credentials (i.e. not a government official). Two common reasons to decline an interview were that they would like to speak to me but didn't think that their responses would result in any change or be heard by the right people so they could not afford the time or conversely the exact opposite, saying that they did not wish their responses to be view or used by the government or agribusiness. Because their information could be used by PFRA and IISD several potential interview subjects declined.

Another difficulty was the agricultural political climate at the time. The 2007 agricultural season had a fair share of controversy in Saskatchewan. The two main issues at the time were the Canadian Wheat Board Barley Plebiscite and the potential purchase of Agricore United by the Saskatchewan Wheat Pool. Of these two issues, the Canadian Wheat Board Plebiscite was particularly sensitive. In addition to having to compete with other surveys taking place over these issues, the Wheat Board topic would often come up in conversation with interviewees. Opinions on the issue varied significantly between area residents. Some producers were very open with their opinions whereas others were quite secretive. The division in opinions made it difficult at times to utilize the snowball method of obtaining new interview subjects. When asked, a high percentage of respondents would either provide some names but wish to remain anonymous or they would refuse to refer friends and neighbours either to spare them the trouble or because they did not want there to be any potential for their opinions to be known.

3.5 CRISTAL

CRISTAL (**C**ommunity-based **Ri**sk **S**creening **T**ool-**A**daptation & **L**ivelihoods) is a computer-based program developed by the IISD, IUCN, SEI-B and Intercooperation that was modified and used to facilitate the research preformed. It is a tool that was developed to offer local communities, project planners and managers a way of doing interactive climate risk management for planned or ongoing projects (IISD et al. 2005). CRISTAL's objective is to answer four major questions;

1. How past climate hazards have impacted the research area
2. Which resources and strategies are used for coping with these climate impacts
3. How specific projects and policies affected the availability and access to resources essential to livelihoods and coping strategies, and,
4. How to adjust the projects/programs to enhance the availability and access to these resources (IISD et al. 2005)

The decision to used the CRISTAL program as opposed to a standard questionnaire was based on a presentation made by Alec Crawford and Anne Hammil of the IISD at a conference in Winnipeg. The interactive nature of the program combined with the design and flow of the questions presented an opportunity to test the program in the field as a research tool. This required some modification to the program (Appendix D) as well as some initial testing with family involved in agriculture. Based on the changes which could be made to the program and my initial testing, modifying CRISTAL as a research tool was added to the thesis objectives.

For use in this research, CRISTAL began by collecting basic information (Figure 1-5). The names of the interviewees were collected as a number, location was recorded as either the northern or southern study area, the implementing agency was recorded as IISD/NRI and the brief description in the project box was used to record farm size, type, farming experience and whether any significant changes to the on-farm operations had

occurred in the past 5 years.

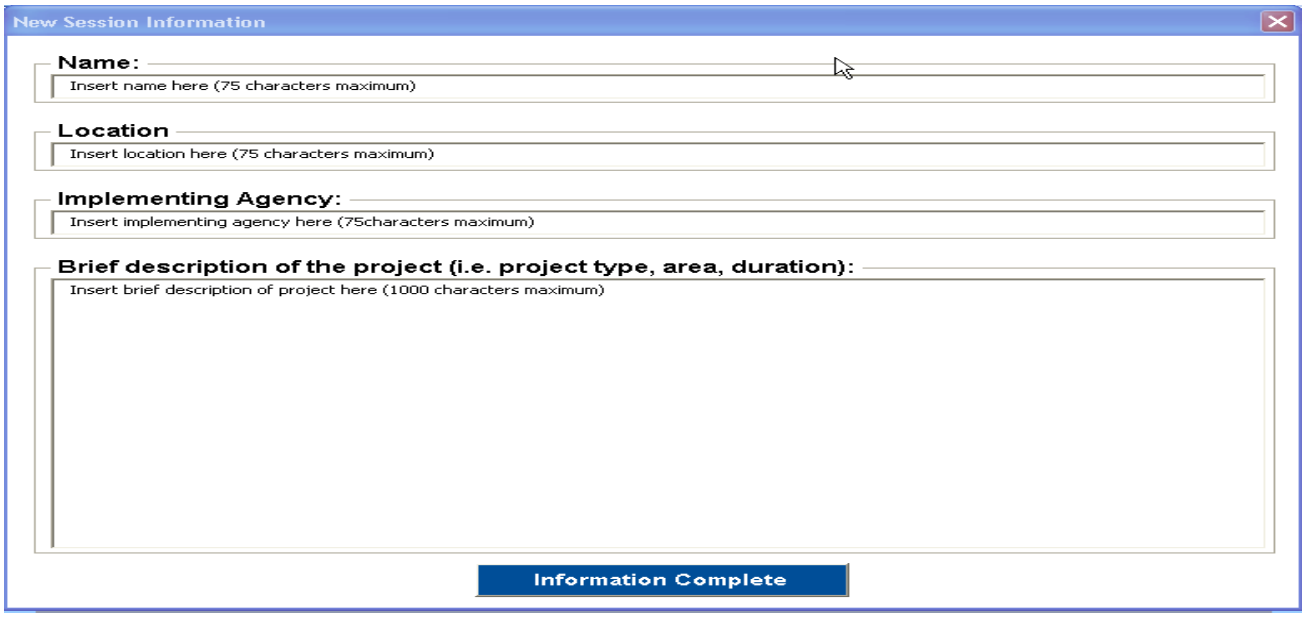

Figure 1-5. New Session Information stage of CRISTAL

Following the input of basic information, the climatic context of the interviewee was defined. This began by first entering where the project/interviewee was taking place or located (figure 1-6).

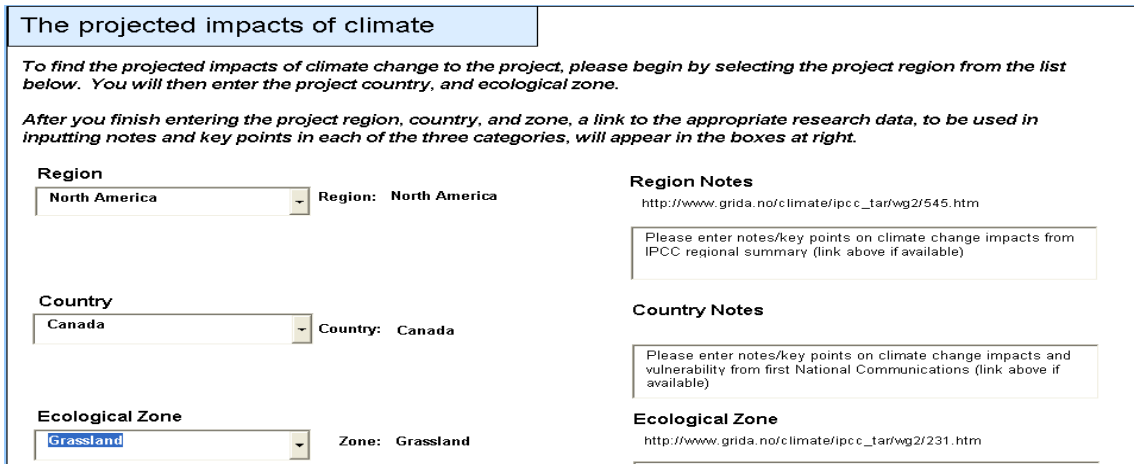

Figure 1-6. Defining the climatic context

From this point, more detailed and specific information was gathered regarding the

climate context. A producer would begin by listing what weather events had impacted his operation, what were the subsequent impacts of these weather events and what coping strategies were used to minimize these impacts (Figure 1-7).

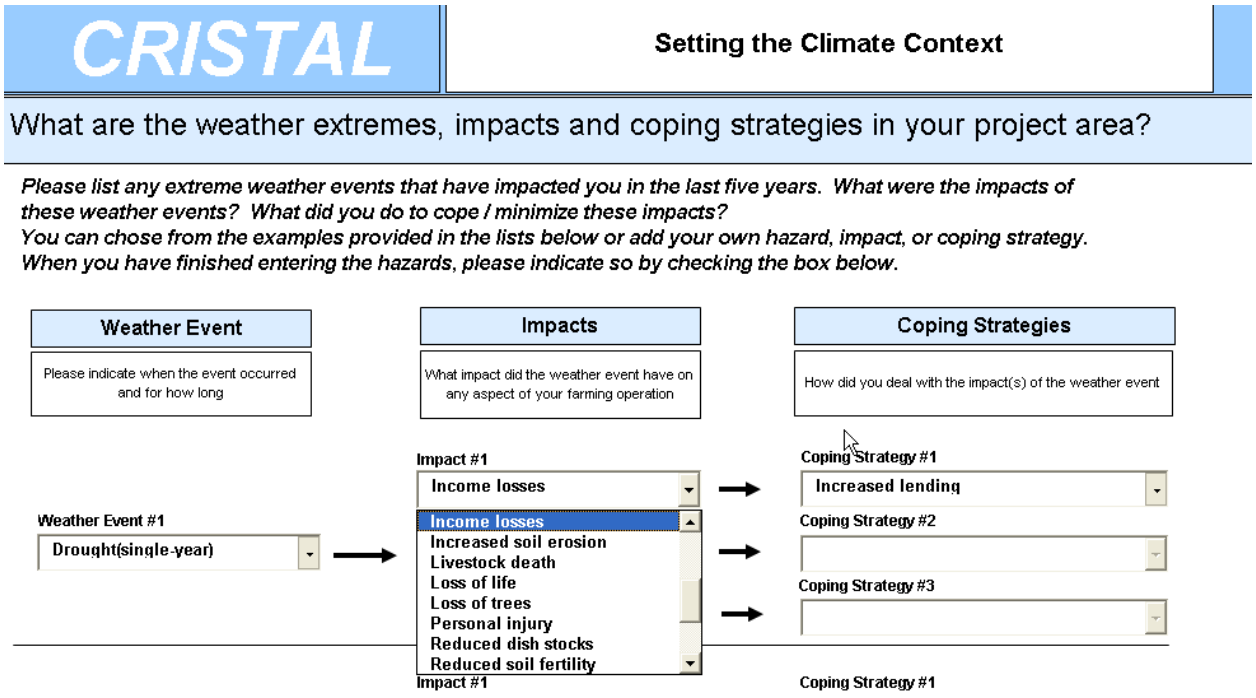

Figure 1-7. Recording weather events, their impacts and coping strategies used.

CRISTAL featured the option of typing a specific response or allowing the interviewee to select from a drop down list of responses. A limitation can be seen in figure 1-7 which shows that only 3 impacts and 3 coping strategies could be selected by the respondent.

At this point CRISTAL looked at the livelihood context of the interviewee. Figure 1-8 shows how this information was collected. Up to three important resources were identified in five categories: (1) natural resources, (2) infrastructure, (3) financial resources, (4) human resources and (5) social/community resources. From this stage the impact of the previously mentioned weather events determined in figure 1-7 were ranked from 0 (no negative influence) to 5 (large influence) on each of the chosen resources. For

example an interviewee may have indicated that he was affected by a single year drought. In the livelihood context section of CRISTAL, after listing the important resources to his farming operation, he would then indicate whether or not the weather event had a negative impact on each resource.

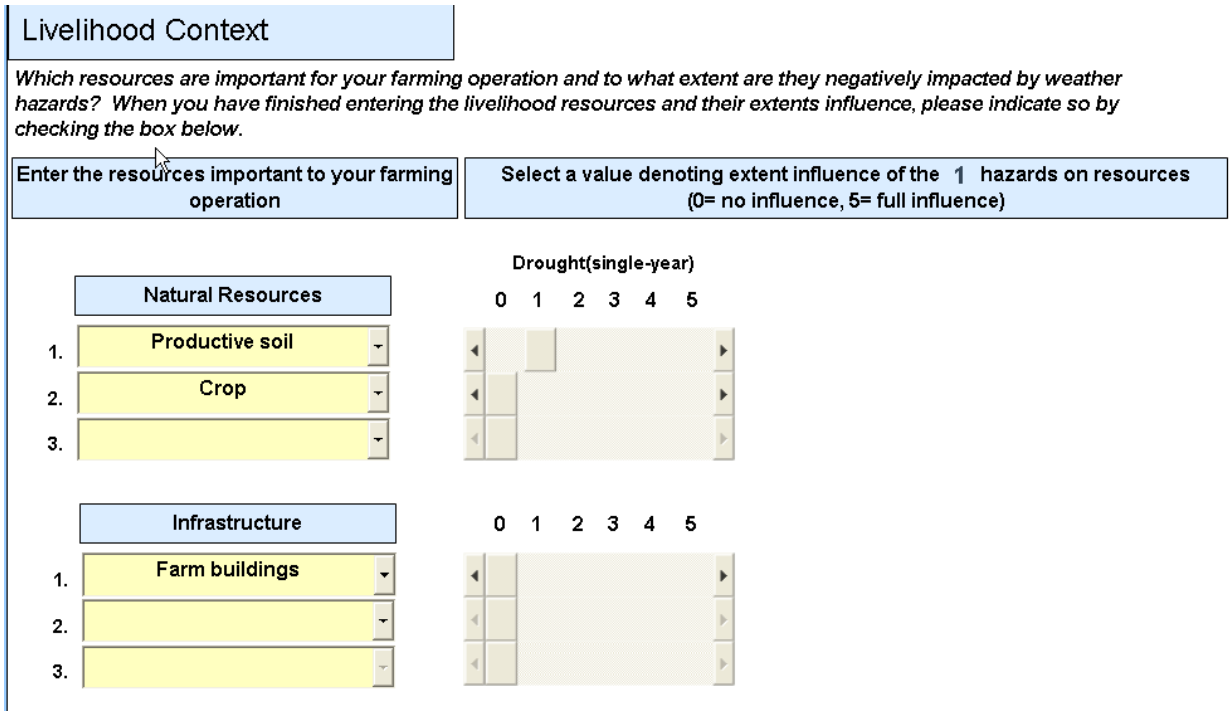

Figure 1-8. Determining the impact of the weather events on important livelihood resources

After ranking the effect of the various weather events on important livelihood resources, the importance of these resources was then related to the coping strategies earlier mentioned (Figure 1-7) for each weather event. Figure 1-9 shows how this was again accomplished using the 0-5 ranking system. For example, as shown in figure 1-9, during a single year drought, a producer used the coping strategy of increased lending to minimize the impact of income loss. This section of CRISTAL would now indicate how important the livelihood resources chosen in figure 1-8 are to the coping strategies indicated in figure 1-6.

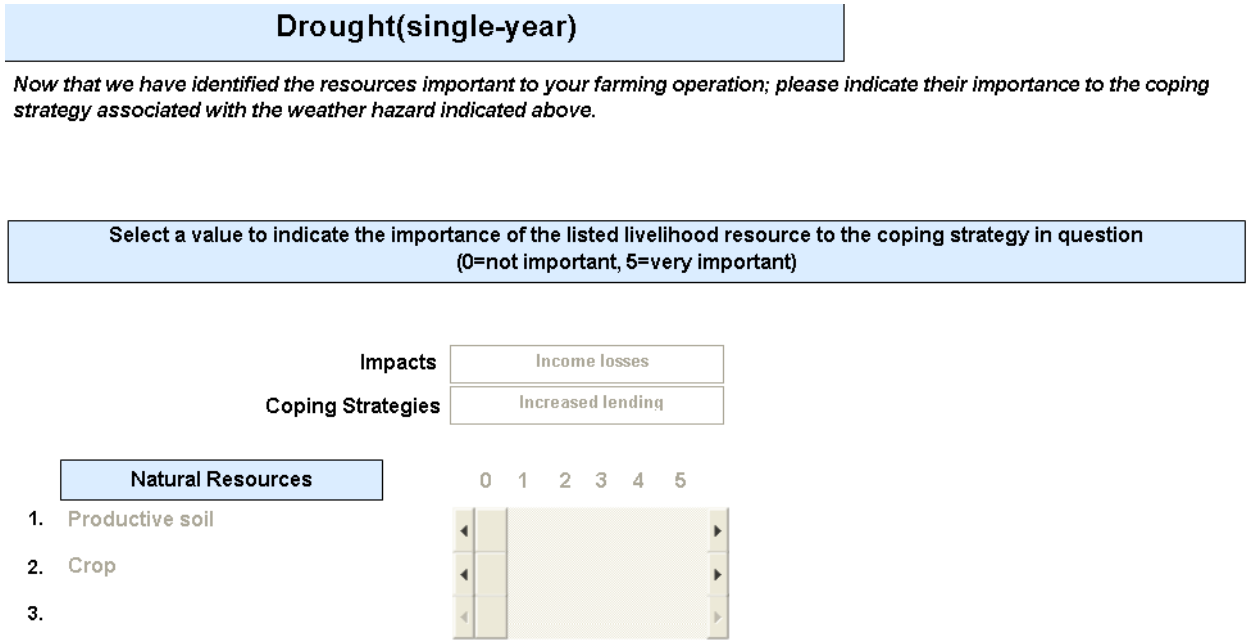

Figure 1-9 . Ranking the importance of resources to coping strategies.

Using the results from figures 1-8 and 1-9 CRISTAL flagged resources most negatively affected by weather events (viewed as having an impact ranking of 4 or 5) and resources most important to coping strategies (ranking of 4 or 5) to determine the effectiveness of programs. Figure 1-10 shows how interviewees would list the programs they used in their farming operation and whether or not these programmes had a positive, neutral (no effect), negative or no applicable effect on the resources most negatively affect by weather events and resources important to coping strategies.

Screening Policies and Programs

You will now begin to assess the impacts of the different policies and programs on
(a) the livelihood resources that have been identified as being most negatively affected by the hazards and
(b) the livelihood resources that have been identified as being important to coping strategies.

Please enter the policy or program in the yellow spaces provided (at left) and indicate whether the impact of the activity is positive, negative, neutral, unknown or non-applicable (click on each for definitions) using an "X" in the appropriate box. Please select only one box for each resource.

Activities	Impact of activity on resources most negatively affected by hazards						Impact of activity on resources most important to coping					
Policy / Prgram 1	Resources	Pos	Neg	Neu	Unk	NA	Resources	Pos	Neg	Neu	Unk	NA
Crop insurance		X										
Policy / Prgram 2		Pos	Neg	Neu	Unk	NA		Pos	Neg	Neu	Unk	NA

Figure 1-10, the effect of programs on resources most negatively affected by weather events and resources most important to coping.

Figure 1-11 now shows the next step in which CRISTAL flags all programs and resources which received either a positive or negative rating and allows for an explanation of why this program was positive or negative and how it could be improved.

CRISTAL **Adaptation Management Planning**

Adaptation Management Planning

Agricultural policies / programs that were flagged as having a positive or negative effect on key livelihood resources have been identified.

Please enter why the policy or program had a positive or negative impact and any suggestions on how they could be improved.

Policy / Program	Flagged Resources by Weather Hazard	Impact of Policy/Program on Resource		Why positive/negative? Improvement suggestions
Activity 1		Positive	Negative	
Crop insurance	Productive soil	X		

Figure 1-11. Why programs flagged to have a positive or negative effect on resource and how they could be improved.

The final component of CRYSTAL is a summary project profile which displays the

results from each section in a report format (Figure 1-12). Unfortunately these reports could not be merged therefore I created a backup excel version of CRYSTAL so that results could be easier tabulated and narratives could be included with the CRYSTAL data.

Implementing Agency:

IISD

Brief Description of the Project:

Grain farm, farm 6100 acres, cerceral pulse soil seed. Been farming for 25 years in area, family

been farming since early 50's. Farm opertation stayed the same in the last 5 years.

Project Region

North America

Project Country

Canada

Project Ecological Zone

Grassland

Hazard	Impact	Coping Strategy
Hailstorm 2005 July	Crop damage/loss	Insurance hail/crop
	Income losses	
Frost 2004, cold summer	Income losses	Insurance crop
	Crop quailty	Increased lending
	Crop damage/loss	
Drought(single-year) 2003	Crop yeild	1
	Income losses	
Heavy rain 2002 (20 days at harvest)	Crop quality	Take loss
	Income losses	

Figure 1-12 example of summary project profile

For the purposes of this research CRISTAL had to be modified from a program for project managers into a research tool. The changes, however, did not modify the organization of the program as seen in figure 1-13.

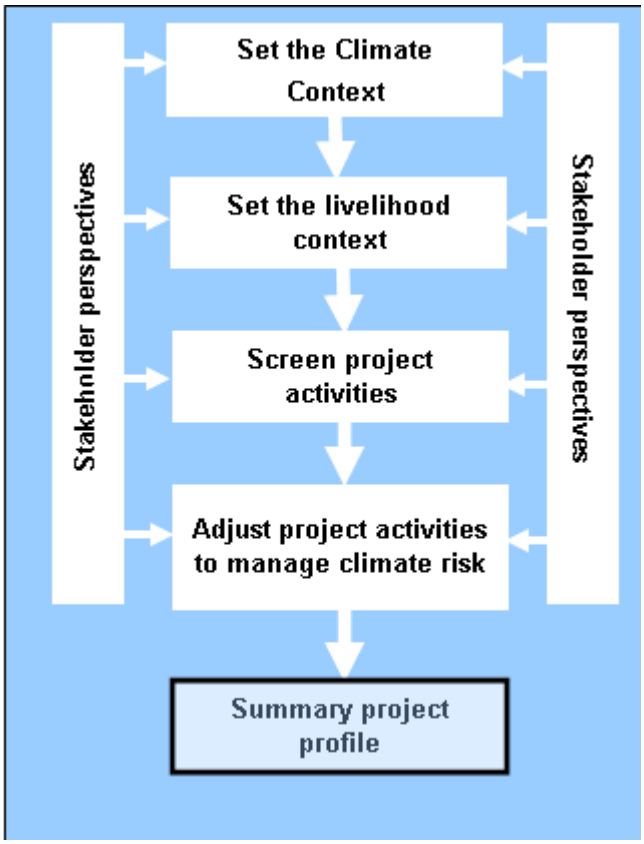

Figure 1-13. Organization of CRISTAL

A detailed list of changes made to the program can be found in Appendix E as well as the definition of terms used by the program in Appendix F.

Chapter 4- RESULTS

4.1 Weather Events

In total 38 producer interviews were performed with 23 taking place in the northern study area and 15 in the southern study area. Both the northern and southern study areas were affected by several extreme weather events in the past ten years (Table 2). Interviewees were asked to list the weather events in recent history which came to mind and then rank the negative effect it had on their farming operation. Rankings were on a zero to five scale (zero having no effect, to five having a major effect). Only weather events with a ranking of four or five are included in the results.

Table 2. Frequency of weather events identified by respondents as having a major effect on their farming operation. (Northern Study Area *n*=23 Southern Study Area *n*=15)

Weather Events	
Northern Study Area	Percentage of Respondents
Early Frost	87%
Drought	74%
Flood/Excessive Moisture 1999-2004	61%
Hailstorm	57%
Extreme heat 2007	39%
Wet Harvest	13%
Windstorms	17%
Early Snow 2004	9%
Southern Study Area	Percentage of Respondents
Early Frost	74%
Flood/Excessive Moisture 1999-2004	47%
Hailstorm	33%
High Humidity	33%
Extreme heat 2007	27%
Late spring snowfall	20%
Wet Harvest	13%
Drought	13%
Windstorms	7%

4.2 Weather Events in Northern Study Area

The northern study area was affected by several weather stresses over the past five years. The most significant were early frost, drought, flooding/excessive moisture and hailstorms. These four events affected over 50 % of respondents and have reoccurred in the area on varying levels over a 5 year time period. The possibility of early frost has always been a major concern in the area. An early frost has the potential to severely downgrade or completely decimate a year's production, reducing profitability and increasing difficulties in harvesting and grain marketing. In the northern study area, early frost was the most significant weather event identified by respondents, with 87% identifying it as affecting their farming operation. 2004 was identified as a particularly bad year for frost by most respondents. Although frost is a commonly reoccurring weather event, the frost in 2004 struck very early at harvest time and affected nearly everyone in the region. The affects of this event varied but for some in the area it resulted in total losses.

Drought is a continuous concern in the northern study area with 74% of respondents viewing it as having affected their operation. Fortunately the area surrounding Regina has a soil type known as 'Regina Heavy Clay'. The high clay content in the soil does permit good moisture retention for single year drought occurrences but does remain vulnerable to multi year droughts.

The opposite concern to drought is local flooding. Respondents varied dependent on location and soil type. This weather event presented itself more as a farm specific event highly dependent on topography. Flooding and excessive moisture mainly occurred as spring flooding events or persistent moisture in low lying field areas. At the regional scale, spring road washouts were a concern exacerbated by the flat terrain and high clay content of the soil. While flooding has always been a concern, more concern exists today for the possibility of flash flooding. Several interviewed producers addressed this

concern citing an observation of less steady gentle rains in the area with the higher frequency of thunderstorms and heavy rains releasing several inches at once.

Related to the higher frequency of storms in the region is the 57 per cent of respondents who identified their farms as being affected by hail. Because of the highly localized nature of hail, damages in the area varied and occurred yearly. 2005 was identified by several respondents as being a particularity poor year because of hail in which crop damages/losses ranged up to 50% in some of the affected areas.

4.3 Weather Events in Southern Study Area

Weather events in the southern study area had less of an effect on farming operations when compared to the north. According to several producers in the area "the past five years have actually been fairly good weather wise" (Estevan Area Producer, April 2007). However, many producers were still adversely affected. As it was in the north, early frost was the number one weather event indicated in the southern study area with 73 % of interviewees indicating it as affecting their operation. Contrary to the north however, the southern research area ranked flooding and excess moisture as the second most frequent weather event. This can somewhat be tied to 33% of respondents in the area reporting higher levels of summer humidity. This region does have much more water present than in the north. The availability of water in the southern study area dramatically reduced the effects of drought when compared to the northern study area. It should be noted however that with farming operations being more of the mixed type in this region, the effects of a single weather event can be perceived as being less drastic. For example while a hailstorm might drastically reduce the harvest and income of a strictly cereal and pulse crop operation, a more diversified operation with a secondary revenue source such as livestock may not perceive a similar event as being as extreme.

4.4 Weather Impacts

The northern and southern study areas experienced somewhat similar impacts associated with the weather events (Table 3). The weather impacts shown in the results are once again seen as having a significant effect on the producer's operation (4-5 ranking in CRISTAL). Crop damage/loss was the number one impact in both the northern and southern study areas. This response was common because it covered all levels of effects and ranged from total crop loss to minor damages. More specific responses and secondary effects to the crop damage/loss ranked lower and many are only associated with specific weather events.

Lower yields are another commonality between the northern and southern study areas and can be associated to weather events which struck during crucial growth periods reducing grain quality and bushels per acre. Frost and unusual temperatures (high or low) were a major causational factor in reducing yields. It is the combination of all impacts that resulted in income loss for both areas. The percentage of respondents who cited income loss was surprisingly low considering the losses some producers have taken. However, it should be remembered that the questions focused on the weather events and impacts rather than financial questions.

Table 3. Reported significant weather impacts (4-5 ranking in CRISTAL). Northern study area *n*=23 southern study area *n*=15.

Weather Impacts	
Northern Study Area	Percentage of Respondents
Crop damage/loss	87%
Lower yields	39%
Reduced seeding area	39%
Equipment damage	22%
Income loss	17%
Harvest difficulties	17%
Increased Pest activity	17%
Delayed Seeding	17%
Farm Building Damage	13%
Slow crop growth	9%
Added field operations	9%
Reduced crop residue	4%
Southern Study Area	Percentage of Respondents
Crop damage/loss	67%
Lower yields	33%
Income loss	33%
Disease	33%
Rapid Crop Growth	27%
Harvest difficulties	20%
Added field operations	13%
Reduced seeding area	13%

The differences between the north and south study area weather events are reflected in the resulting impacts. The higher incidences of drought in the north are reflected in several of the specific impacts. Increased pest activity, slow crop growth and reduced crop residue are all results of drought in the area. Contrary, in the south, flooding and high humidity brought about increased disease, rapid crop growth and reduced seeding area. Other common impacts such as harvest difficulties and added field operations encompass a wide range weather events requiring an increased work load on the land or difficulties in accessing it. A major difference in impacts between the two study areas is in the area of income. While both indicated loss of income as a major impact, weather

events had less of an effect on income in the northern study area. One reason for this difference may be attributed to farm size which is larger on average in the northern study area. For example, common localized events such as hail can severely reduce a particular field's yield. While this does have an effect on a 15,000 acres farm in the northern study area, the effect of hail may be much more drastic on a 3,000 acre farm in the south.

Responses to weather events

4.5 Coping Strategies in Northern and Southern Study Areas

The responses or coping strategies displayed by producers in both the northern and southern study areas were wide and variable. Responses varied from having to take the loss, to changes in farming operations and product sales (Table 4). Many of the responses were dependent on the type of farm. For example, the use of row covers in the northern study had a low response of 1. In this particular case, the producer who used row covers to protect against heat and wind was a small scale vegetable producer. This option, while very effective, is obviously not a viable choice for the majority of the respondents who farm grains, oil seeds, pulse crops and livestock on a much larger scale.

Both regions had several common responses or coping strategies. These included taking the loss, the use of Saskatchewan crop insurance, zero or minimum tillage farming practices, and hail insurance. These four results are common in nearly 100% of all interviewees, however, they were not always self identified as a coping strategy or response to a weather event. In fact, the use of zero tillage is so common place in Saskatchewan that it is no longer seen as an innovation but rather as the standard farming practice amongst interviewees. It has been so successful that several interviewees mentioned that perhaps the effects of recent droughts may have been much more severe prior to the introduction of zero tillage farming techniques.

Table 4. Reported coping strategies to weather events in the northern (*n*=23) and southern (*n*=15) study areas.

Northern Study Area	Percentage of Respondents
Take the Loss	78%
Sk Crop Insurance	65%
Zero/Min Till	43%
Hail Insurance	35%
Multiple field locations	17%
NISA payment	13%
Early Harvest	13%
Delayed Harvest	13%
Seed short season crop	13%
Multiple year grain storage	13%
Use crop as feed	13%
Ethanol	9%
Small land drainage	4%
Maintaining Fertility Program	4%
Increased Lending	4%
Marketing change	4%
Late seeding	4%
Specialty Crops	4%
Seed to hay	4%
New Equipment purchase	4%
Modify Equipment	4%
Irrigation	4%
Row Covers	4%
Increased spraying	4%
Southern Study Area	Percentage of Respondents
Sk Crop Insurance	87%
Zero/Min Till	53%
Use crop as feed	53%
Take the Loss	40%
Hail Insurance	27%
On farm Management	27%
Increased spraying	27%
Holistic Ranching	20%
Marketing change	20%
Early Harvest	13%
Late seeding	13%
Ethanol	13%
Seed to hay	13%
Leave crop on field to retain snow	13%
Increased Lending	7%
Delayed Harvest	7%
Multiple field locations	7%

One of the most common responses was “taking the loss”. This response referred to not having the ability to take a specific action in the case of a particular weather event. The popularity of this response stems from several reasons, the first being that the majority of farming operation decisions are made well before the growing season starts. This implies that when a major weather event strikes, the producers has no choice but to accept the loss as it is already too late to make any possible changes to farming practices. An example would include a major hail storm. The producer, other than purchasing hail insurance, has no ability to predict the arrival of a storm and very few options after it occurred. There are no major changes to the farming operation that can occur to help prevent future losses from the same occurrence. In most cases the only option is to recover what is available, take the loss and use any purchased insurance to minimize the financial effects of the hail.

It is the use of insurance to help with the common response of “taking the loss”(no other option but to accept the income loss) which results in both Saskatchewan crop insurance and municipal and private hail insurance ranking high amongst responses. While not used every year, the vast majority of Saskatchewan farmers purchase at minimum Saskatchewan crop insurance. The price and level of coverage varies greatly from fifty to one hundred percentage coverage but in the case of a “take the loss” situation, it becomes invaluable to the producer.

Beyond the common responses of taking the loss and insurance programs, the remaining coping strategies identified by respondents generally represent innovation and specialities to certain operations. The most common innovation identified as being a coping strategy in both study areas was the wide spread use and acceptance of zero or minimum tillage farming practices. This method of farming was introduced widely in the area approximately 15 years ago and has since become the most common farming method. Interviewees who cited it as a response to weather events praised it for its use for the ability to retain moisture and prevent widespread erosion. Many respondents cited the

use of zero tillage farming as a major factor in being able to survive weather events and being largely responsible for favourable growing conditions for the past five years. Other innovations include the use of multiple field locations. The use of this coping strategy was more common on larger farms in the northern study. It is the practice of using multiple field locations to limit the effect of regional weather events. For example, spreading out field locations, whether intentional or simply a necessity due to land ownership and field rental locations, spreads out a farming operation's resources and limits losses associated with localized weather events. This could include frost, hail, flooding etc. Having a greater diversity of land locations and conditions often prevents total losses for producers. Related to multiple field locations is also the practice of maintaining a diversified farming operation. This is the practice of growing multiple crops and/or with the combination of livestock or other financial opportunities. Growing a wider range of crops provides an inherent resilience to the producer. Different crops can be more or less susceptible to weather events and gives a wider time range for seeding/harvest. The practice of diversifying farming operations is now common place on Western Canadian farms due to improved farming management practices, new markets for a wider variety of crops and crop rotation practices. The success of diversification can be seen in the results where the more diversified southern research area has a lower reported frequency of simply "taking the loss". A diversified farm operation has more opportunity for responses to weather events then a more monoculture operation.

Other responses included changes to farm management practices. Examples were delaying harvest, having an early harvest, planting a short season crop etc. Several other farm operation changes responded to the weather events by using marketing opportunities. Very often this included cutting losses for a given year by selling damaged grain as livestock feed or after a series of poor years, seeding farm land to hay specifically for sale on the feed market or use in a mixed farming operation. More recently, a common trend in Saskatchewan has been the switch by many producers to

devote a certain percentage of their land for ethanol production. This move is heavily supported by both the federal and provincial governments. There currently exists several ethanol production plants in or close to both study areas. This provides an opportunity for producers as the production of utility grain for ethanol requires less work from the producer. For ethanol production a lower quality grain is used which can tolerate a wider degree of climatic variation and is not judged by the same standards as food quality grain. Having ethanol plants in the area also ensures a local opportunity for grain sales. While not directly related to the weather, the move towards ethanol has been politically motivated as a response to climate change by both the federal and provincial governments. The financial help it provides to producers gives them a greater opportunity to absorb shocks and stresses associated with increased weather variability and the financial power to implement change and innovation.

4.6 Resources Important to Coping Strategies

Behind the coping strategies used by producers in both the northern and southern study areas are the resources which give them the ability to cope with weather events and to make adaptations to future weather events. Table 5 illustrates the farming operation resources that have been self identified by producers as being very important to their adaptation and coping strategies (4-5 ranking in CRISTAL)

The results from the northern and southern area show that both areas rely heavily on natural (management of physical conditions), financial (savings, government programs, insurance, credit and off-farm employment) and infrastructure resources (farm buildings, implement technology and social/community structure) to cope. The number one response in both areas is the actual production of a crop. The annual production and sale of a crop or livestock is the keystone to all subsequent resources such as farm savings, liquid assets and farm implements. It is these subsequent resources on which farm operations rely in situations where harvest results are poor due to weather events. This demonstrates the importance of financial security to having the ability to adapt and cope

through increased weather variability associated with climate change.

Another resource common to both research areas and one which ranked high previously as a coping strategy is insurance and transfers from the state (government support). Interestingly, while insurance and transfers from the state ranked high as a response to weather events, they ranked relatively low as a resource important for coping strategies. This reflects the sentiments of many producers stating that "insurance and government support are important but farming operations are not planned around these resources" (multiple producer respondents, spring/summer 2007).

Table 5. Resources identified as very important to weather event coping strategies in the northern (*n*=23) and southern (*n*=15) study areas.

Northern Study Area	Percentage of Respondents
Crop	87%
Savings	61%
Insurance	52%
Agriculture Implements	39%
Liquid Assets	22%
Transfers from the State	17%
Farm Buildings	17%
Soil	17%
Livestock	13%
Water	13%
Grain storage	13%
Credit systems	4%
Hired Help	4%
Local Greenhouse	4%
Farm hands	4%
Farmers Market	4%
Local Restaurants	4%
Southern Study Area	Percentage of Respondents
Crop	87%
Savings	60%
Liquid Assets	53%
Agriculture Implements	53%
Livestock	40%
Farm hands	40%
Soil	40%
Employment in town	27%
Insurance	13%
Transfers from the State	13%
Family Help	13%

The differences between the northern and southern study areas are fairly small with the difference in importance associated mainly with insurance and greater off farm employment opportunity. Less importance placed on insurance in the southern study area may be a factor of the diversity naturally incorporated in farms of the southern study area.

4.7 Resources Most Negatively Affected by Weather Events

Resources which can be grouped into the categories of natural, financial and infrastructure resources, were identified by Saskatchewan producers in this study as being most important for having the ability to cope and adapt to the effects of weather events. Table 6 demonstrates the resources which are most negatively affected by weather event in both the northern and southern areas[2].

Results show that resources most negatively affected by weather events and resources most important to coping with weather impacts mirror each other closely. This shows the vulnerability that currently exists in both the north and southern study areas. The negative effects of weather events on crop, financial and infrastructure resources demonstrate vulnerability especially to weather events that occur in multiple years. It is during these events that financial strain can prevent adaptation and lead to heavy use of insurance and government subsidies.

[2] Only results receiving a 4 or 5 (criteria for being considered significant in CRYSTAL) were represented.

Table 6. Resources most negatively affected by weather events in the northern (*n*=23) and southern (*n*=15) study areas

Resources most negatively affected by weather	
Northern Study Area	Percentage of Respondents
Crop	83%
Insurance	39%
Savings	35%
Liquid assets	17%
Water	17%
Roads	13%
Water	13%
Grain storage	13%
Agriculture Implements	9%
Farm Buildings	4%
Credit systems	4%
Farm hands	4%
Transfers from the State	4%
Southern Study Area	Percentage of Respondents
Crop	87%
Savings	73%
Liquid assets	40%
Insurance	27%
Credit systems	13%
Water	13%
Transfers from the State	13%
Soil	13%
Farm Buildings	13%

Chapter Five: DISCUSSION

5.1 Effectiveness of Government Programs on Important Farm Resources

A commonality between northern and southern study areas is the use of government programs. All interviewees took part in a least one government program, with only one exception, who did not use any programs at all. The list of programs used is wide ranging, with the four most common being Saskatchewan Crop Insurance, Canadian Agriculture Income Stabilization program (CAIS)[3], Net Income Stabilization Account (NISA)[4] and the Environmental Farm Plan. These programs were cited as being used in over 50% of the interviews. The other programs mentioned were much more limited in their use or perceived importance to coping with weather variability. Examples include the wheat board cash advance, GRIP, Educational bursaries and the PFRA shelterbelt / dugout program. The four most common programs do have an effect on resources important to coping and the resources most negatively affected by weather events (Table7).

Generally Crop insurance was seen as a positive program by the majority of users. It is recognized that purchasing crop insurance is a necessity of farming because it covers farmers in situations where little else can be done on farm and accepting the loss of income is the only option. An unpopular move has been the removal of hail insurance from general crop insurance. If a producer wants hail insurance for their operation it must now be purchased separately from the RM or a private insurance broker.

[3] CAIS was a federal agriculture program designed to protect farm income from risks such as weather, disease and low market prices. It was discontinued for the 2007 program year and was replaced with Agristability and Agriinvest (*www.agr.gc.ca/**cais**/main.html)*

[4] NISA was a federal agriculture program for long term income stability by providing producers the opportunity to deposit money annually into their NISA account and receive matching government contributions. The program ended in 2004 (*www.agr.gc.ca/**nisa**/welcome.htm)*

Coverage rates, expenses and claims are other common complaints. The opinion of many producers is that coverage payments increase much too rapidly from 50% to 60% and so on, making it not worth the investment to purchase more then basic coverage. In order to improve the program, producers would like to get rewarded for responsible farming practices. Producers using the latest technology and farming techniques see themselves as doing everything possible to avoid having to make an insurance claim. These producers would like to see their good farming practices rewarded in insurance rate reductions.

This sentiment reflects the opinion of Smithers (1998) who found that crop insurance decreases the adaptive measures of producers. The crop insurance program, while contributing to financial security does not reward or promote innovation. In the context of social-ecological resilience (Walker et al. 2004), crops insurance could be viewed as a program which aides in the capacity of a system to absorb disturbance but does little to support adaptability. As it currently stands, producers who want to significantly change their farming operations risk leaving the safety and support of the crop insurance program. It should be noted, however, that crop insurance was never designed to increase adaptability or to promote change. Like other insurance programs, crop insurance is intended to simply provide support after a loss.

CAIS was an extremely unpopular program which was recently replaced by the Agristability and AgriInvest programs (Ag. Canada, 2009). The majority of producers did not understand how the program functioned or did not receive any form of payment. Because of the time and complexity of the paper work involved with the program, it was mostly completed by professional accountants. In conversation with an interviewee, CAIS was jokingly referred to as the Canadian Accountant Income Stabilization program (Northern Study Area Producer, January 2007) because of this fact. Producers were commonly unsure if they were eligible for a payment from CAIS and if they were, they

did not know when payments would be made. "I did receive a payment from CAIS during the BSE crisis, it wasn't much but it helped, two years later I was informed that they wanted the payment back. I of course had already spent the money; it was all a major inconvenience" (Southern Area Producer, August 2007). "CAIS involved a lot of paper work, I paid 4-5 thousand dollars to an accountant just to find out I wasn't qualified. People I know that did receive payment got it 2 years after the impact which is way too long" (Northern Area Producer, January 2007). The CAIS program was designed with the idea in mind that producers and the government would share the cost of replacing income when production margins fell below a reference margin (Agricorp 2007). Determining the reference margin was where many of the difficulties occurred. This proved especially difficult with mixed farming operations where portions of total grain produced was consumed by animals on farm. Because of the difficulties associated with this program, it was replaced shortly after this research concluded.

The Environmental Farm Plan was a popular program used in both research areas. The program consists of a five step process:

1. **Workshop 1 –** Trained facilitators and technical assistants introduce producers to the EFP workbook and work on assessing the soil and site characteristics of their operations. The EFP workbook will aid in recording relevant information and identifying areas of strength and of concern.
2. **Risk Assessment –** Producers review all aspects of their operations and record their findings in the EFP Workbook. They identify potential risks and solutions and commence development of their Environmental Farm Action Plan (EFAP).
3. **Workshop 2 –** With a completed workbook and the help of the EFP workshop facilitator, producers finalize their EFAP to determine the steps required to manage any identified risks, and to prioritize action items.
4. **Peer Review –** In order to access financial incentives, completed EFAPs must be submitted to a Peer Review Committee for confidential review.
5. **Implementation –** When the Peer Review Committee has endorsed the action plan, producers will be eligible to apply for financial incentives under the Canada-Saskatchewan Farm Stewardship Program and Greencover Canada. These programs give producers access to cost-shared funding to implement eligible management practices identified in the Action Plan. (Government of Saskatchewan 2005)

The environmental farm plan is a producer driven program which, although it requires the producer to make significant investment, it offers the opportunity for these costs to be shared by the government. The educational component of this program combined with financial aid has made it popular. Producers saw it as helping to improve their operation while benefiting the environmental health of the region and improving the reputation of Saskatchewan agriculture. The success and popularity of the environmental farm plan represents a positive move away from the findings of the Canadian Senate committee on agriculture and forestry interim report on climate change (2003) by:

- Promoting adaptation to existing vulnerabilities as opposed to those only reacting to extremes and
- Adapting in a proactive manner instead of taking purely reactive measures

This program also supports changes to farm operations and can be used by small speciality farms, mixed farming, and large grain/oilseed/pulse crop operations. The environmental farm plan directly aided interviewees in this research through support for drip irrigation for fruit production, row covers for organic vegetables, solar water pumps for cattle and GPS precision steering devices for farm machinery.

Table 7- Four most common government programs and their effect on resources important to coping and most negatively affected by weather events in the north and south study areas (*n*=38). (x) Indicates the most common response.

Polices / Programs	**Impact of program /policy on resources most negatively affected by weather events**					**Impact of program /policy on resources most important to coping**				
Crop Insurance	**Resources**	**Positive**	**Split result**	**Negative**	**N/A**	**Resources**	**Positive**	**Split result**	**Negative**	**N/A**
	Crop	x				Crop	x			
	Savings			x		Insurance	x			
	Insurance				x	Savings		x		
	Agriculture Implements	x				Liquid assets		x		
	Liquid Assets		x			Water				x
	Transfers from the State	x				Roads				x
	Farm Buildings	x				Grain storage		x		
	Soil	x				Agriculture Implements	x			
	Livestock		x			Farm Buildings	x			
	Water				x	Credit systems			x	
	Grain storage		x			Farm hands				x
	Credit systems			x		Transfers from the State	x			
	Hired Help				x	Soil	x			
	Local Greenhouse				x					
	Farm hands	x								
	Farmers Market				x					
	Local Restaurants				x					
	Employment in town				x					
	Family Help		x							

Polices / Programs	Impact of program /policy on resources most negatively affected by weather events					Impact of program /policy on resources most important to coping				
CAIS	**Resources**	**Positive**	**Split result**	**Negative**	**N/A**	**Resources**	**Positive**	**Split result**	**Negative**	**N/A**
	Crop		x			Crop		x		
	Savings			x		Insurance			x	
	Insurance			x		Savings			x	
	Agriculture Implements		x			Liquid assets			x	
	Liquid Assets			x		Water				x
	Transfers from the State			x		Roads				x
	Farm Buildings		x			Grain storage				x
	Soil		x			Agriculture Implements		x		
	Livestock			x		Farm Buildings		x		
	Water				x	Credit systems			x	
	Grain storage				x	Farm hands				x
	Credit systems			x		Transfers from the State			x	
	Hired Help			x		Soil				x
	Local Greenhouse				x					
	Farm hands				x					
	Farmers Market				x					
	Local Restaurants				x					
	Employment in town				x					
	Family Help				x					

Polices / Programs	Impact of program /policy on resources most negatively affected by weather events					Impact of program /policy on resources most important to coping				
Environmental Farm Plan	**Resources**	**Positive**	**Split result**	**Negative**	**N/A**	**Resources**	**Positive**	**Split result**	**Negative**	**N/A**
	Crop	x				Crop	x			
	Savings	x				Insurance		x		
	Insurance		x			Savings	x			
	Agriculture Implements	x				Liquid assets	x			
	Liquid Assets	x				Water	x			
	Transfers from the State	x				Roads				x
	Farm Buildings		x			Grain storage				x
	Soil	x				Agriculture Implements	x			
	Livestock	x				Farm Buildings				x
	Water	x				Credit systems	x			
	Grain storage				x	Farm hands				x
	Credit systems		x			Transfers from the State	x			
	Hired Help				x	Soil	x			
	Local Greenhouse				x					
	Farm hands				x					
	Farmers Market				x					
	Local Restaurants				x					
	Employment in town				x					
	Family Help				x					

Polices / Programs	Impact of program /policy on resources most negatively affected by weather events					Impact of program /policy on resources most important to coping				
NISA	**Resources**	**Positive**	**Split result**	**Negative**	**N/A**	**Resources**	**Positive**	**Split result**	**Negative**	**N/A**
	Crop	x				Crop	x			
	Savings	x				Insurance		x		
	Insurance		x			Savings	x			
	Agriculture Implements	x				Liquid assets	x			
	Liquid Assets	x				Water				x
	Transfers from the State	x				Roads				x
	Farm Buildings				x	Grain storage				x
	Soil		x			Agriculture Implements	x			
	Livestock		x			Farm Buildings		x		
	Water				x	Credit systems	x			
	Grain storage		x			Farm hands				x
	Credit systems	x				Transfers from the State	x			
	Hired Help				x	Soil	x			
	Local Greenhouse				x					
	Farm hands				x					
	Farmers Market				x					
	Local Restaurants				x					
	Employment in town				x					
	Family Help				x					

NISA is the final common program and has been discontinued. The final payments from this program were being made in 2007 while I was conducting interviews. This program was the predecessor to CAIS. It allowed producers to enter money into voluntary savings account which would be matched by the government (Ag. Canada, 2008). The simplicity of the program is what made it popular. Producers knew what they had available and could plan accordingly. If they were impacted by a weather event, they could access their money for help. Unfortunately the program was cancelled largely due to the older generation of producer's unwillingness to use the money saved when near retirement. Despite it being cancelled it still remains a popular program in Saskatchewan.

Adaptations and innovations of resilient producers

The vast majority of producers who participated in this survey could largely be combined into two groups: those whose farming practices follow the status quo or regional average techniques, and those who differentiate from status quo and use new technology and innovation. These innovative producers are often referred to as leading farmers (Scholz 2007) and tend to enjoy greater security financially and also demonstrate a higher resilience to weather variability. Examples of innovations are extremely wide ranging, and the scale to which they are used is highly variable. This chapter will discuss six categories of innovations which closely relate with the findings of the best practice group (2007), showing a relationship between innovation and success despite high weather variability.

5.2 Specialty Crops

The movement to speciality crops is a departure away from the commodities market. Commodities are sold in a competitive market where those who can produce the most and sell it for the least will benefit. Under this system, producers have largely experienced low prices for their crop. Low crop prices in turn leave producers financial vulnerable

during periods of poor weather. The production of a high value speciality crop can help a producer increase their stability by being able to operation in outside markets. This can often involve local sales or direct marketing. The concept of growing a specialty crop is to produce a product which is in high demand but currently has a small supply. The movement towards speciality crops represents a strategic farm-level adaptation (Bradshaw et al. 2004). Transitioning to a specialized crop requires significant research and thought. If done in addition to more traditional farming practices the producer receives the added bonus of diversifying his operation.

Speciality crops were found to be grown in both the northern and southern study areas. Two crops of particular interest, cherries and fireweed/rumex, were found in the northern study area. An interviewee who exclusively produced cherries represented an example of a farming operation that focused exclusively on a speciality crop. The interviewee began farming with his father in 1993. Together they ran an 1120 acre pulse, oil seed and grain farming operation. A death in the family, new machinery expenses and the combination of a bad frost in 2004 and a 60% loss to hail the following year prompted the interviewee to cease farming operations and begin renting all but 4 acres of his land. The 4 acres was set aside for the production of dwarf sour cherries. At the time of the interview the cherry trees were too young for production. However, the goal was to process the cherries in the onsite production facility for sale in the nearby Regina farmer's market, summer road side fruit stands and custom orders. The dollar per acre potential is around ten thousand dollars per acre with low maintenance and input costs. Once fully established the cherry operation would help to supplement the income of family members working in town and allow the interviewee to remain at home with the family.

The cherry production is seen by the interviewee as a regional speciality that can take advantage of the nearby farmer's markets, proximity to the Trans Canada highway and the popular nearby tourist destinations. Support for the production of this speciality crop

came from the Canada-Saskatchewan Farm stewardship program (environmental farm plan) and aided in the funding for the fruit trees, increased shelter belts, drip irrigation system and wildlife fencing.

The production and basic processing of fireweed and rumex in the northern study area is an example of a speciality crop being used to supplement more traditional farming practices. The interviewee in this example, a northern study area producer, farms approximately 10,000 acres of peas, feed wheat, canola, oats, 32 cattle and 5 acres of fireweed and rumex. The cultured production of fireweed and rumex is not common in Saskatchewan. Fireweed and rumex are both common weeds growing wild in Saskatchewan and the Prairies. Rumex tends to grow in areas where water is plentiful and fireweed is common in areas of disturbance. Harvesting of these weeds in a wild situation is open to the public, however this interviewee had obtained an exclusive contract to plant, grow and process for the region.

The intentional growth and harvest of common weeds seems like an unusual agricultural activity. The products they produce however are quite valuable. Fireweed is sold to the pharmaceutical company Johnson and Johnson that use it for the production of skin care products ranging from baby wipes to salves for burn victims. Rumex is in demand in Asian markets where it is used as a key ingredient in skin lighteners.

In total, both crops were seeded on a 5 acre plot. During the growth period, other weeds were removed to ensure maximum growth. Just prior to the commencement of the usual harvest, the plants were handpicked by two hired farm hands. The harvested plants are placed in a farm building over air driers and are routinely turned to prevent mould and fungal growth. Once the plants are dry they are placed into a machine which grinds the dried plants into a fine powder. This powder is in turn sold in Saskatoon for 8 dollars a kilogram. In total 5 acres of this weed produced the equivalent value to the producer as 9

quarter sections of wheat.

In both examples of specialized crops production, the crops demonstrated a high tolerance to weather variability. Trees and weeds both naturally have a high tolerance to shocks and stresses from the weather, but also the small scale on which they were grown allowed the producers to take action to prevent damage during weather events. With this low risk crop the producer's farms have an overall greater tolerance to weather events and impacts.

5.3 Direct Marketing

Western Canada has traditionally sold agricultural produce in bulk. This is highly facilitated through the Canadian Wheat Board and is the choice method for the sale of commodities. More and more Saskatchewan producers however have begun seeing opportunity in taking control of the sale of their product. The result of this is the movement towards direct marketing. Direct marketing is the action of the producer selling directly to the consumer/purchaser. The direct sale of an agricultural product to a consumer/purchaser almost exclusively requires it to be a specialized product, which one producer or a small group of producers could provide. For example, while a single producer's grain or oil seed crop could be very difficult to direct market to a consumer/purchaser, a speciality crop or rare crop could realistically be sold. Examples would include organically produced products, locally grown produce (farmer's market) or a regional speciality. Direct marketing can also be used in cost recovery situations. A common example in both the northern and southern research areas is the selling of downgraded grain for livestock feed.

Whether used as a tool to sell high value products or in an example of cost recovery after a weather event, direct marketing gives the producer an advantage in removing the cost of a middle man. When the producer is selling directly to the consumer, the producer has the ability to set the price and avoid potentially expensive handling and transportation

costs. Direct marketing does require a significant amount of work and innovation on the part of the producer. Done properly, however, the producer can build a significant amount of financial security which in turn helps develop resilience into their farming operation. An example of this can be seen with a livestock producer in the Southern research area who had been a traditional grain farmer and decided to switch to a livestock operation 10 years ago. He made the switch by seeding 800 acres from grain to grass and purchasing 250 cattle, 5 sows and 400 chickens all with the goal of becoming a holistic rancher.

After about 10 years of building up his grass and cattle herd, this southern area producer now directly markets his cattle. He can produce a semi load of holistic cattle for slaughter giving him the power to set the price for his speciality product and the power to choose to whom he sells (buyers for the cattle found on the internet). The reduction in input cost such as fuel, pesticides and antibiotics mean that his profit margins are higher and the health of his grass and soil eliminate the effects of short term weather events. His form of production also has numerous benefits for the region. Local area flooding is reduced as thick grass prevents runoff, the soil sequesters carbon, methane production from cattle is reduced and neighbouring farms can receive small payments to allow cattle to graze stubble. Conversion to this method of farming was supported by; (a) Ducks Unlimited which helped pay for the switch to grass or permanent cover, (b) local communities who offer holistic management courses and (c) watershed authorities who help cover 1/3 of the cost for cross fencing. This innovative farming method allows the producer to have a greater chance of achieving financial stability by being in control of the sale of his product and it is achieved in a manner that works more in harmony with the environment, allows for extreme weather events, and works with cattle's natural feeding habits. This farming method was an adaption this producer made to maintain controlled production on his farm. The changes made to this farming operation show a remarkable level of adaptability and resilience. By changing farming methods to holistic ranching and having the ability to market directly, this producer's farming operation have

shown a significant amount of social-ecological resilience. The farm now has a larger capacity to absorb disturbance and reorganize while undergoing change while still retaining the same function as comparable ranching operations in the area (Walker et al. 2004). In addition to being more resilience, examples such as this demonstrate a high level of resilience thinking by adopting a farming method that deals with the future uncertainty associated with the unknowable shocks and stresses of climate change (Berkes 2007).

> "A farmer cannot control outside forces such as the weather and politics. Worrying about them solves nothing. What a farmer can do is affect what he controls such as the method in which he farms. Increasing strength over what you control reduces the affect the outside forces have on your farm" (Figure 5-1 Southern Area Producer 2007)

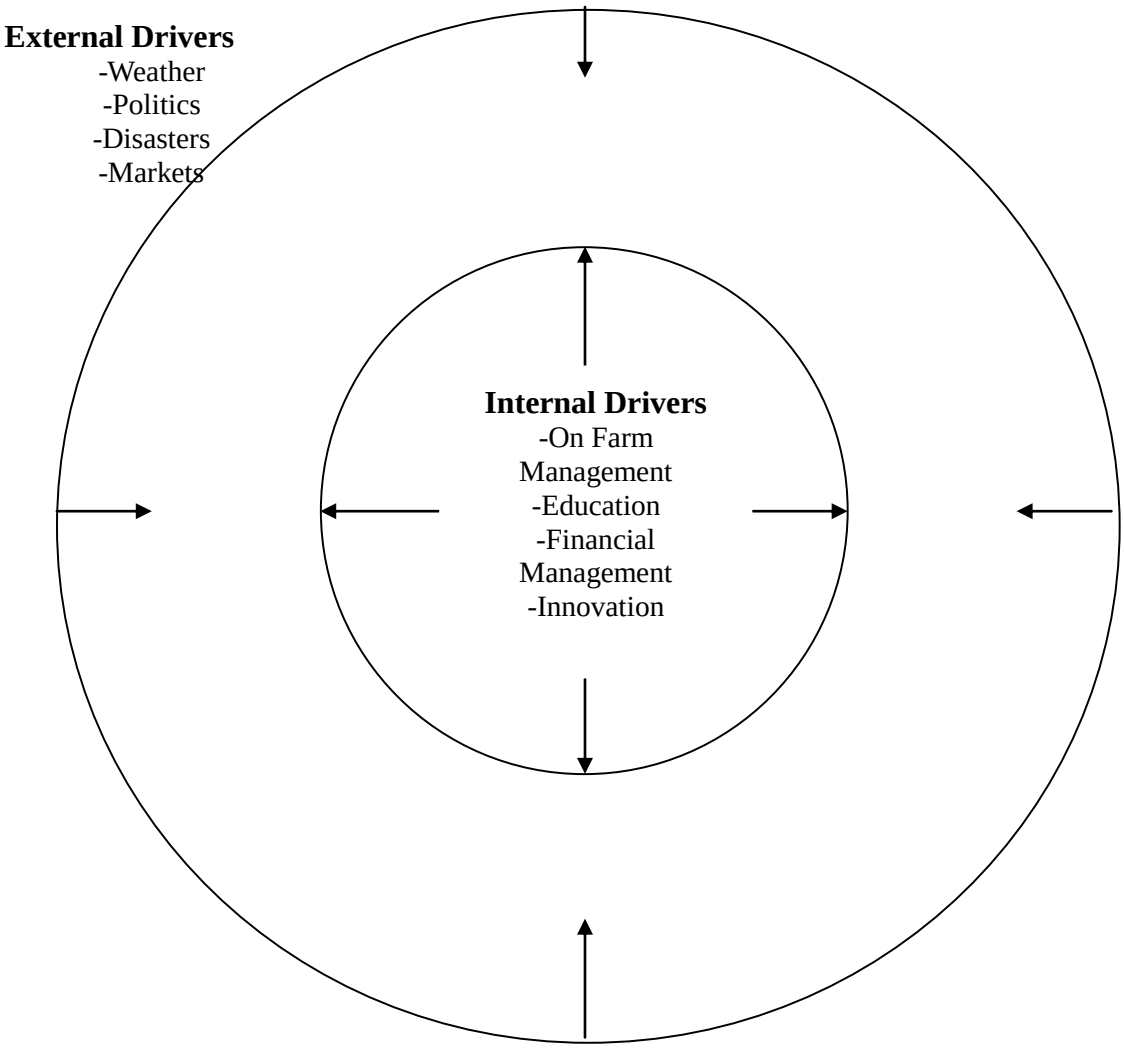

Figure 5-1- Demonstration of how controllable on farm choices minimize uncontrollable external stresses (Southern Research Area producer 2007)

5.4 Interdependence

The idea of the independent farmer is very strong in both study areas. Each producer owning their own land and equipment is common for the vast majority of interviewees. There are however a few examples of interdependent producers. Interdependence is a new example of old traditional farming practices being used in the present. It can be referred to as the pooling of human and equipment resources in an effort to save on rising input costs. Like threshing machines of the past, interdependent producers may not own all the equipment or all the land used for their farming operation. It is a form of "back to the future thinking, or thinking back forward" (Southern Area Producer, April 2007), where producers can reduce costs by pooling resources which can in turn help build resilience to weather events.

The concept of interdependence offers the opportunity to increase agricultural adaptability at varying scales. As Smithers and Blay-Palmer (2001) suggest, technological advances and machinery improvements could be made at an organization level through producer groups, industry or local/provincial government. An example would include the Saskatchewan-based, Farmers of North America use of the port of Churchill. The Farmers of North America group were able to save on the fertilizer costs by receiving a shipment of fertilizer through the port of Churchill, MB. By bypassing Montreal and Thunder Bay, western producers were able to save 10% on costs (CBC, 2007). Interdependence can be used more commonly at the local level through tactical adaptation methods like equipment sharing.

A good example of local interdependence existed in the southern study area. A southern study area producer was able to make a living off of 500 acres of land with no off farm income. This is a very small parcel of land when compared to most Saskatchewan farming operations but it works in this situation because of interdependence. The producer pooled his labour and equipment with his father and brother. Instead of each

family member owning individual farm machinery, the costs were shared amongst each family member's farm. Instead of three sets of farm equipment working three small farms, there was one set working three farms. This reduced costs for each farming operation by a third. The result was less impact to each farm due to weather events as there was less impact on each farm's financial resources.

This form of interdependence worked in this situation because labour and shared operating expenses for equipment, which can range up to three hundred thousand dollars, could be counted upon. As a result, expenses were drastically reduced on a per farm basis, allowing a 500 acres grain farm the opportunity to make a profit.

Another example of interdependence can be found in the northern study area. The rising cost of equipment and inputs has dramatically increased. This has made operating and purchasing new equipment very expensive. A practice now used to minimize some of these costs is custom farming. This type of farming occurs where an area farmer who owns equipment and has time will help a neighbour's farming operation for a fee. This allows a producer's farming operation to remain in operation when he/she does not have the time and/or money to purchase new equipment, allowing a producer with the proper equipment an opportunity to recover some operating costs.

Interdependence is not limited to equipment and labour. It can also be used to reduce purchasing expenses by pooling the purchasing power of several operations or also when selling to reduce transportation costs. Essentially any situation where an advantage can be achieved through resource pooling could be considered interdependence.

5.5 Education and Expert Advice

Education and the use of expert advice is a common trend among all participants who displayed innovation in their farming techniques. This may include attainting a

university or college, outside work experience, on farm education or attending local workshops and expert lectures. The value of education can be seen in basic production but also in adaptation and management during weather events, farm management/planning and human resource management. The advantages of this were seen in the northern study area with 3 neighbour participants. All three attended the University of Saskatchewan's agriculture program at the same time. The commonalities between all three farming operations were clear. Each had detailed farm management plans and good record keeping, all three were run in as business like fashion and stood out as successful farms in the region. Each to varying degrees used direct marketing, speciality crops and interdependence to their advantage and all three closely monitored weather conditions and had backup plans for extreme weather events. Through their education, these producers had learnt that by keeping records of their actions and observing the weather they were able to learn from previous experience with weather related shocks and stresses and make well planed changed to their farming operation. Their emphasis on learning from past experience demonstrates how resilience thinking (Berkes 2007) has aided them in reducing vulnerability.

5.6 Next Generation Management

While the vast majority of farms have gotten bigger and moved to a more 'corporate' method of operation, maintaining and involving the future generation of producers is essential. Without a network of family run farms in Saskatchewan, rural decline will continue. As rural populations have decreased in the past, small towns have disappeared or lost significant services. Elevator closures, last of postal service, medical offices, school service and basic service stores all add expenses to producers and decrease the likelihood of the subsequent generation from continuing the operation. A decrease in the number of ratepayers within an RM also decreases the ability of the municipality to respond to the effects from extreme weather events such as spring road washouts. Interviewees in the northern study area commented on spring washouts of roads preventing their children from being able to make it into town to attend school. With

children having to remain at home and other family members working off farm, producer cannot work a full day on the farming operation.

From the research conducted in the northern and southern studies, it is clear that the average age of producers is rising. The majority of participants had been farming for over 20 years with 0 having less than10 years experience as a producer. Most interviewees in conversation made it clear that their children were either attending school or working in the city. In speaking with two second generation children who have taken employment in the city, they don't perceive there being a future in farming. "If I thought I could return to the farm tomorrow and make a decent living I would be there. I love the farm but my dad and I have talked and know the opportunities are in town." (Son of a northern study area interviewee 2007). "I still help out on the farm during the busy times of the year, it really makes me miss living out there but I have a much more stable job in town and my kids have a nearby school. "(Son of northern study area interviewee 2007).

From speaking with the second generation, it is clear that the desire to remain in agriculture is strong but they have been encouraged by their parents to seek a more stable lifestyle in the city. Next generation management is a way to get the second generation involved in the operation at an early age to help maintain future generations of producers. Next generation management begins with the first generation. Accurate record keeping and a well documented farm plan must be developed. The current operation should be evaluated and future opinions considered. Future options would include movement to new high value crops, new farm technology and farming methods and consideration for reaction to future weather patterns. "I believe 100% that climate change is real and occurring. It won't be the end of farming but we have to adapt and change. We have to begin looking at more drought tolerant crops and crops that can be harvested in less than ideal conditions" (Northern Study Area Producer 2007).

With a detailed plan in place, the entire family can be involved with farm operation decisions. By involving the second generation in decision, the potential for opportunity and valuable experience can be gained. This valuable on farm experience combined with off farm education, will give the second generation a higher probability of remaining on farm as highly skilled farm operators with the ability to adapt to changing farm conditions including weather events and impacts. The possibility of a more stable financial living from the farm may entice those who enjoy farm life, but needed a better financial living, to stay on the farm. A farming family in the southern research area provided an example of a farm using next generation management. They ran a 2000 acre mixed farming operation with 1300 acres seeded with grain and 120 cow/calves. During our interview it was clear that their son was fully involved in the farming operation. In the past ten years the farm had changed to direct seeding, eliminated the onsite hog operation and had begun changing focus to grains and oilseeds. By having his son involved in the operation he was able the good and bad aspects of farming. He saw how the hog market had changed and how direct seeding had kept yields high during hot and dry summers where rains have ended in early June. In the future he will have the experience and knowledge to make a confident decision on whether to remain on the farm or to seek other opportunities.

The importance of second generation management is of particular note in the findings of the best practices of leading farmers (2004), who found that amongst several commonalities, top farmers tended to be family based operations with family members as shareholders in the farming operation. The maintenance of family based operations and a strong rural support network have a strong link to the overall resilience of agriculture in the prairie provinces and the four critical aspects of resilience (Walker et al, 2004). By keeping families on the farm and rural services available, the likelihood of having a greater number of farming operations on the landscape is much higher. With there being a greater number of farms present, this increases the odds of there being more diversity in the types of farms present. Greater numbers of farms combined with diversity give the

system a higher degree of latitude and offer less resistance to change. The opposing situation of large more mono cultured farming operations present a situation in which the agricultural system has more difficulty changing and exists in more of boom/bust type environment where profits and expenses are large. In this situation the system has a high level of precariousness and if it were hit by multiple weather or non weather related events, recovery could be difficult.

5.7 Zero Till

The conversion to zero till farming practices has been highly successful in Saskatchewan. Zero till is a method of farming in which tillage is completely eliminated. Seeds are directly injected into the soil using air pressure and the previous year's crop residue remains on the soil. The result is a farming practice that is successful in maintaining soil moisture, reducing soil erosion and reducing field time and fuel expenses. This is achieved by the maintenance of root systems and organic matter in the soil. By maintaining organic structure on the field, surface runoff and snow drifting is reduced, keeping more natural moisture in the soil (Figure 5-2). The fuel savings are manifested by the producer having to make less passes on the field. Less field time also has the added benefit of affording the producer more time to concentrate on other aspects of the operation or to expand the area farmed. "Zero Till has been the most significant change that I've seen in my time farming. Since I've changed I've been very happy with it. My production went up and my time in the field went down" (Southern study area producer, August 2007).

A consequence of zero till is higher chemical use when compared to farming methods using a higher level of tillage. Tillage is a chemical free method to destroy root networks of weeds. By eliminating tillage, weeds must be now removed chemically. Although zero till farming does have numerous advantages, the consequence of higher chemical use cannot be completely ignored. "We used to have swallows everywhere around here.

There used to be nests all over the place. You rarely see them anymore though. I think it's because we use way more chemicals then we once did. They are used to kill weeds and the insects the swallows eat" (Southern area producer, July 2007).

Figure 5-2. Organic matter left on soil from zero till

Conversion to zero tillage in Saskatchewan began largely 15 years ago. Change was brought about by industry and promoted through word of mouth. Neighbours saw how yields of producers who had made the switch had improved and began attending local information seminars and started purchasing the equipment necessary for the switch. Today zero till is much more refined then it is was in the beginning and remains very popular. All grain producers involved in this survey used zero till or minimum till farming practices to at least some degree.

The ability of zero till to maintain soil moisture and reduce soil erosion has brought a higher degree of stability to Saskatchewan grain farmers. "The weather has definitely been more variable in the past 10 years but with zero till we've always managed to pull

off a fairly decent crop" (Southern research area participant, April 2007). "Zero till helps me to capture snow in the winter and maintain soil moisture in the summer. In a hot dry summer it's your saved moisture that keeps your crop growing (Northern research area participant, June 2007).

Zero till is a good example of a technological advancement that has greatly aided and perhaps masked some of the effects of drought occurrences and climate change. Interviewees noted that Saskatchewan is in a drought prone region of the country. Of great concern to one northern study area interviewee were the findings of Shindler and Donahue (2006) who predict a water crisis of quality and quantity in the western prairie provinces in the near future do to climate warming. The interviewee commented on how water conservation projects developed by PFRA after the droughts in the 1930's have been abandoned while growing evidence suggests that drought in the area will be a more common occurrence. With the findings of Agriculture and Agri-food Canada's 2005 synthesis report on the 2001-2002 drought supporting the prediction of a future water crisis, a fear that does exist is that the success of zero till may be hiding the need for water conservation and irrigation projects in Saskatchewan.

Ranking Innovations

The practicality of these farming innovations varies. While making use of all of them to some degree would be ideal, the reality of farming does not always allow for this. Ranking of the aforementioned innovations or prioritizing these changes is therefore an important action. Based on the results and interviews the innovations presented would rank as follows:

1. Education and Expert Advice- This innovation was a common trend amongst all participants who demonstrated innovation in their farming technique. Seeking education and advice makes it easier for a producer to successfully make changes to their farming operation and find new innovations or opportunities.

2. Zero Till- Zero or minimum tillage is a very successful innovation in Saskatchewan. It has nearly become the normal farming practice. Producers who have made the switch to this farming practice have enjoyed a greater resilience to drought and are overall happy with the change.
3. Specialty Crops- Producing a speciality crop in addition to normal farming practices adds diversity to the farming operation. Growing a speciality crop often allows a producer to direct market their product and generally receive a high price.
4. Direct Marketing- Selling directly to a buyer allows a producer to receive a higher price for their product. In most cases this requires a producer to have a speciality crop. More profit for a producer can help bolster savings or allow for future invest in innovation to help through weather events.
5. Interdependence- This innovation can reduce cost and allows for exchange of ideas. Practically is limited, however, and therefore reduces its ranking.
6. Next Generation Management- Maintaining families in farming is important, however realistically it is difficult and is dependent on numerous factors. That is why this innovation ranks lowest.

5.8 Northern Versus Southern Study Area Comparison

The similarities and differences between the two study areas yield some interesting results. From the weather events, it is clear that early frost, excessive moisture, hailstorms and extreme heat have affected both study areas. What appears to be significantly different is the occurrence of drought. Drought was reported to have a major effect on 74% of respondents in the northern study area versus only 13% of respondents in the southern study area (Table 2). As previously mentioned in the description of the two study areas, the northern area is naturally in a drier portion of the province when compared to the southern area, so this result was not unexpected. What it highlights, however, is that the northern study has two water resource concerns, drought and localized flooding/ excessive moisture. The southern study also has the issue of flooding/ excessive moisture. These weather events contributed to many of common

weather impacts between the two regions such as crop damage, lower yields and income loss. What stands out in the coping strategies between the two areas is the lack of water resource management. Irrigation and land drainage appear only as minor coping strategies. In the northern study area where drought significantly impacted 74% of respondents, irrigation was only used by 4% of interviewees. With regards to flooding/excessive moisture in the northern study area, 61% were significantly affected by moisture, but coping strategies such as small land drainage and seeding to hay only accounted for 4% of responses in both cases. The same is true in the southern study area. Where flooding/excessive moisture was identified by 47% of respondents as having a major effect on their farming operation, drainage did not present itself as a coping strategy and seeding consistently wet acres to hay was only performed by 13% of interviewees.

The lack of significant response to these weather events is an area of concern. Climate change is predicted to bring increased periods of drought along with greater degrees of weather variability (Shindler and Donahue 2006). This most likely means extended periods of drought and increased occurrences of heavy rainfall. The introduction and popularity of zero till or minimum till farming practices has aided in reducing the effects of drought. Both the northern study area (43%) and southern study area (53%) viewed it as being an important coping strategy. The benefits of zero till in maintaining soil moisture have aided recent droughts however their benefits would be limited in prolonged periods of drought. Concern over the lack of irrigation use, drainage or overall watershed planning is shared by Schindler and Donahue (2006) and Venema (2005). Both indicate that land managers, watershed planners and policy makers have seldom considered the cumulative effects of climate change, drought and human activity. The northern and southern study results support the fact that little region irrigation, storage or drainage plans/infrastructure have been put in place. By implementing better water resource management in the farm and region level, the predicted effects of future droughts and extreme weather could be minimized and as Wall et al. (2004) suggest, the

longer potential growing season could be used towards the advantage of the producer.

The northern and southern study areas also showed an interesting difference with regards to the use of coping strategies. The northern study area showed taking the loss (78%), SK crop insurance (65%), zero/min till (43%), hail insurance (35%) and multiple field locations (17%) as the top coping strategies (Table 4). The south had SK crop insurance (87%), zero/min till (53%), use crop as feed (53%), take the loss (40%) and hail insurance (27%) (Table 4). The higher importance placed on crop insurance in the southern study area was unexpected. With the northern study area being less diversified and almost solely grain, oil seed or pulse crop based, it was unexpected that crop insurance would have a higher prevalence in the more diverse southern study area. The prevalence of crop insurance was reversed, however, when respondents in both study areas identified resources which were very important to weather event coping strategies. 52% of respondents in the northern study area indicated that crop insurance was very important to their weather event coping strategies versus only 13% in the southern study area (Table 5). This disparity speaks to many of the differences between the northern and southern study areas. Through the evolution of farming in Saskatchewan, homogeneity and large scale farming in the northern study made sense. As technology improved, one producer could work larger and larger portions of land in the relatively obstacle free, good grain land of the Southern Saskatchewan grain belt. The result of this was less diversity. The land in the southern study area, being more diverse and less ideally suited to large scale grain production, has maintained a higher level of farm diversity. Less diversity in the northern study area makes it more vulnerable to catastrophic weather events or long term drought / flooding. In this situation insurance ranks high as a resource important to weather event coping strategies since the loss or down grade of a harvest represent a total loss to the farm. The diversity of the south allows for a greater buffer to catastrophes or prolonged weather events since all the farm's assets aren't invested in one particular crop. The fact that the southern study area had resources important to weather event coping like employment in town (27%) and livestock (40%) ahead of insurance (13%) was evidences of this (Table 5).

5.9Additional Findings

Throughout the course of my research I had the opportunity to speak to several farm groups and organizations. Although their information could not be entered into CRISTAL, they did bring up several important points which complimented the on farm interviews. A commonality amongst several of the agricultural professionals interviewed was their observation of shorter winters and an increased frequency of extreme weather events. These weather related stresses are recognized by agricultural professionals as "one of the most difficult stresses because the producer has no control over it. Despite good planning, in a matter of days, yearly plans can change and a source of income can disappear " (Saskatchewan Wheat Pool, 2007).

Organizations in Saskatchewan do work closely with producers to help increase agricultural resilience. Ducks Unlimited Canada is popular amongst producers for offering payments to maintain wetlands and retain permanent cover for waterfowl. Although their primary goal is maintaining duck habitat and populations for hunting purposes, their payment program for producers to maintain wetlands is helping to reverse drainage practices of the past. The maintenance and enhanced design of natural wetlands does provide drainage and storage during wet years, reducing field flooding and provides a water source during drought. The maintenance of permanent cover around wetland areas also helps keep cattle out of sources of agricultural water. Ducks Unlimited's presence is limited in the northern study area because of the lack of natural wetlands, they are however more active in the southern research area. The Saskatchewan Watershed Authority is also highly involved with producer's water issues offering services such as financial assistance with livestock fencing and solar water pumps. While both of these organizations aid producers both acknowledge that their decisions and ability to implement programs are mostly dependent on political and economic issues. Ducks Unlimited's decisions are mainly influenced by American funding and politics as opposed to regional climatic events. The Saskatchewan Watershed Authority,

being a component of the provincial government, has more of an ability to act on weather events and impacts however they to acknowledged limitations imposed by funding. While they have introduced and implemented several popular programs, they simply lack the man power and funding to ensure they are being properly used at the farm level. "Our solar water pump program is intended to ensure that cattle can get access to water away from wetlands and the producer wouldn't have to install wiring. While it is popular we simply don't have the staff to ensure they are being properly installed on the farm. I know that a lot of pumps are getting dusty in the barn" (Saskatchewan Watershed Employee, 2007).

The Saskatchewan Agrivision Corporation is highly involved with changing business and agricultural practices. Through their research work in the best practices of leading farmers (2007), they have found that despite climate change and weather events, innovative producers can continue to exist and make a profit. Regionally, the Saskatchewan Agrivision Corporation is working on changing the transportation methods of grain and pulse crops. They see bulk grain and pulse crop transportation as an "Achilles heel" of Saskatchewan agriculture. They are currently working with producers to develop a network of overseas shipping containers to allow for the ability to deliver on demand to meet just in time delivery demands. This is an effort to eliminate delays, price undercutting and degradation of pulse crops. (Sk. Agrivision representative, 2007).

Saskatchewan Agrivision is also working directly with producers to get them involved in the value chain. This includes having more control of marketing their product and the development of processing plants (canola oil, ethanol) within the province. According to Agrivision one of the most difficult challenges is changing agricultural traditions. Saskatchewan Agrivision has observed that the top 10% of producers in the province are involved in a commercial enterprise or a producers alliance of some nature. This most often involves a movement away from land ownership to land renting. The sale of land

and subsequent rental of it allows producers to invest more in enterprises and reduces year to year dependency on crops.

Agrivision was the only interview to speak towards the resilience of Saskatchewan agriculture in general. They commented that Saskatchewan is the only agricultural area in Canada that does not have a 50% livestock 50% grain spilt. Currently Saskatchewan operates at a 24% livestock 76% grain spilt. "This puts all of Saskatchewan's agricultural eggs in one basket when it comes to the weather" (Al Scholtz, 2007). Of the potential 66 million acres of agricultural land in Saskatchewan, 40 million is currently cultivated with a remaining 26 million that could be used to diversify Saskatchewan Agriculture with more livestock production. "There is so much potential in Saskatchewan Agriculture, the problem is there is very little leadership and producers look towards the government. Leadership from producers in changing the culture of agriculture is what is needed to move forward" (Sk. Agrivision representative, 2007).

5.10 CRISTAL as a research tool

My impressions of CRISTAL as a research tool have been negative. It is quite obvious that CRISTAL was designed as an analysis tool and while the sequence and type of questions it allowed me to ask did have merit, the practically of its use and difficulty in combining interview results significantly detracted from its potential as a research tool.

CRISTAL did prove to have several positive uses while conducting research. While conducting interviews using CRISTAL, it allowed me to sit side by side with interviewees giving them an unobstructed view of the computer screen and the visual interface. This allowed the interviewee to read the questions being asked as well as allowing them see the answers being typed. This helped build trust as the interviewee could see how their information was being entered and they could instantly verify its accuracy. CRISTAL also ensured that the sequence of the questions asked went in a

logical order from identifying weather events, impacts and coping strategies to more complex questions such as identifying the resources most affected by the weather events in question and the resources most important to coping. This question sequence got the interviewee in the proper frame of mind to deliver information and underlying factors which may not have come out using more traditional interview methods. Interviewees also liked the drop down boxes which helped clarify the questions being asked as well as encouraging more thought to their answers. Conversely, drop boxes did encourage interviewees to give the same or similar answers and limited the number of responses they could give.

CRISTAL did show limitations as a research tool at the organizational level. Because of the increased complexity of farm organizations, interview questions were not easily answered with CRISTAL. For example, from an organizational stand point, extreme weather events could be viewed as a positive event for many organizations because they could develop a higher interest in their services from the farming community as well as more funding from the government. CRISTAL would miss this information because the weather events, although bad, would not be recorded as having any negative effect on livelihood resources from an organization stand point. This fact also reigns true for organizations who's funding and actions are not dependent on the weather (For example, weather has little to no influence on Ducks Unlimited Canada's agricultural programs, because the majority of their funding comes from the United States government. US foreign policy came up as the key factor in this particular organization's decision making.)

Because of time and distance constraints, sometimes the only way the interviews could logistically be completed was by phone. The design and visual nature of CRISTAL made it nearly impossible to complete over the phone in the standard order. General questions had to be asked and conversation directed in order to answer the questions contained in the program however without the interviewee being able to visually see the computer

screen, information was very difficult to obtain

Another difficulty with CRISTAL was amending the program itself. While I could make minor changes to make it an interview tool, I could not makes changes so they would appear on the final reports produced by the program. This was partially solved by creating an excel version of CRISTAL designed for my research. The Excel version was not only created as a backup but also as a means to be able to combine information as data cannot be merged on CRISTAL. Overall CRISTAL could be seen as a prototype for new program. The interview design and the questions asked combined with the open visual nature of the program were positive aspects. It is in time and logistics that many of the advantages of CRISTAL are lost. After I had become well versed in the sequence of questions used in CRISTAL I began conducting interviews with a paper and pen. This allowed me to shorten the interview time and open up interview location options. I found the premise of the program to be successful with the possibility of future applications; however in an agricultural situation, the speed and mobility of a paper and pen are superior.

Chapter 6: CONCULSIONS

Farming is an incredibly challenging occupation requiring constant change and adaptation to a multitude of physical, economic and social events. Climate change and the weather variability associated with it present an increased challenge to producers. From the research conducted in this project, it is clear that the majority of producers see climate change as real and happening. It is the findings of this research that weather events associated with climate change will not bring about the end of farming in Saskatchewan but they do however present a major challenge.

In dealing with an increase in weather variability, very few changes made by producers were made in direct response to the weather. Rather it was found that the majority of changes supported Smith and Skinner (2002) and found that adaptation was occurring through the use of technological development, government programs/insurance, farm production practices changes and farm financial management. The prevalence of financial standing in determining on farm changes highlights the importance of government support promoting adaptability. The environmental farm plan which combined an educational component with cost sharing benefits, proved to be popular amongst interviewees. In order to help producers reduce their vulnerability and adapt to future climate change, additional programs using this model would be advantageous.

In determining how producers in this study responded to weather related shocks and stresses, producers were found to either follow standard farming practices or use innovation. Innovative producers were found to be more adaptable and have a lower level of vulnerability by reducing their exposure to hazards and by adapting methods to deal with future uncertainty (Berkes, 2007, Turner et al. 2003). Instead of relying on government programs, innovative farmers were found to change their farming operation to maximize their natural, human and financial potential. It was these producers who maximized their production during good growing years, who achieved the financial

stability required to keep their farm in a continual state of adaptation and who survived single and multiple poor years to remain in operation.

Research for this thesis was completed using a modified version of CRISTAL for use as a research tool. While CRISTAL was successfully modified for use in the field, the limitations and difficulties in performing interviews and data analysis made its future use as a research tool doubtful without considerable work. Despite its shortcomings in the field CRISTAL still has use in aiding research design and as a tool for project managers, however in an agricultural setting, the simplicity of a pen and paper are superior.

Innovative farmers were found to be resilient for three main reasons. Although their decisions were financially based, they were made with long term goals in mind as opposed to year to year. This generally allowed producers to increase resilience by:

- Increasing options – High value niche crops, multiple field locations, use of new technology and farming techniques all increased options to producers during weather events allowing them to focus on other options when weather events took place.
- Flexibility to switch- Producers who had a willingness to try new crops, technologies and change their mind set showed a willingness to not remain status quo. These producers demonstrated a higher level of current success and potential for future success as they are willing to adapt to new situations.
- No dependence on government programs- Innovative producers made independent decisions based on their farm, independent of traditional government support. Not factoring government support allowed producers to increase their farm options as well as improve their flexibility to switch.

Commonalities amongst successful area producers like the production of speciality crops, use of zero till, direct marketing, interdependence, the use of education/expert advice and next generation management were found to be consistent with the findings of the best

practices of leading farmers (2004) and Wall and Smit's (2005) sustainable farming practices to manage climate and weather risks. It was found that most successful producers employed one or more of these commonalities in their farming operations.

Of all innovations, the incredible success of zero/min must be acknowledged. It provides an example of a technology introduced by industry and promoted by producers. Whether motivated by cost savings, higher potential yields, or soil/moisture retention, the majority of participants in this research have embraced this technology. The method in which zero/min till was introduced to producers and the conversion process warrants further investigation. Despite its many benefits, conversion to zero/min till is not instantaneous and is expensive. It requires new equipment and changes to farm management. By reviewing the process in which this successful conversion took place, the introduction of future technologies or adaptive measure could be accelerated.

It appears that current agricultural programs fall short in promoting innovation. As a matter of fact, Crop Insurance and CAIS do the opposite in rewarding current farming practices. When a producer takes a risk employing new farming techniques he may be removed from the safety of government programs. Changes need to be made which promote and aid producers willing to change and increase their options on the farm. Leadership amongst producers is also needed. Local producers need to reduce their dependency on the government by pooling their knowledge and resources together. Leadership from the government cannot be relied on to drive innovation and change. Programs which are dependent on funding and political influence and may not be appropriate for regional variations. Leadership from industry is also plagued by similar problems. It is through the promotion of producer driven innovation and the willingness to change, that producers will maintain their operations through climate change and weather events. Traditional agriculture will always remain a part of the Saskatchewan agricultural scene but innovation and the increasing in options available to farming operations is what will allow producers to survive and flourish.